THURSDAY, DECEMBER 3, 1903.

THE REFORMATION OF THE TEACHING OF GEOMETRY.

Elementary Geometry, Practical and Theoretical. By C. Godfrey, M.A., Winchester College, and A. W. Siddons, M.A., Harrow. Pp. xi+355. (Cambridge: University Press, 1903.) Price 3*s.* 6*d.*

A New Geometry for Schools. By S. Barnard, M.A., Rugby, and J. M. Child, B.A., Technical College, Derby. Pp. xxvi+514. (London: Macmillan and Co., Ltd., 1903.) Price 4*s.* 6*d.*

EIGHT years ago the writer of this review, when publishing a small book on geometry for the use of pupils of eight or nine years of age, was assured by many friends that the attempt to get rid of Euclid's order and language was a hopeless one, and that, even if it were successful, the foundations of all logical thought in England would be destroyed. Against a strong conservatism it seemed vain to point out that the great developments of modern geometry were made by European mathematicians who were not brought up on Euclid. The question had been tackled before, but with no success. When, however, the British Association and the Mathematical Association appointed committees to grapple with the matter in earnest, the victory of reform was assured. The former body thought it wise to lay down generalities, while the latter went into such minute details as to the course to be pursued by teachers, and the propositions which should be included in school instruction, that it has been possible to embody its recommendations in definite systematic treatises, such as the two excellent works the titles of which are quoted above.

That some recognised order of deduction must be established is a fact which is forced upon anyone who has to perform the part of an examiner, more especially for the public service, and the fact that there is a close agreement, not only in method, but in order, between the two works before us shows that the difficulty of dethroning Euclid is quite imaginary.

Each of these books is a vigorous protest against the extraordinary contention which we have sometimes heard, that "you must make bad figures in geometry so that the logical faculty of the pupil shall receive no assistance from them." Rule, compass, set square, and protractor are now the tools with which the young pupil begins his acquaintance with this subject; and we venture to say that, under the new system, the typical schoolboy will change his attitude of repugnance to "that beastly Euclid"; the subject will actually become popular.

The work of Messrs. Godfrey and Siddons begins with fifty-nine pages of "experimental geometry," in which the pupil is taught to draw various figures by the use of scales, compasses, &c. There is no formal list of *definitions*; the definitions are given as they are required.

Messrs. Barnard and Child open with a list of definitions, each of which, however, is illustrated by a good clear figure, and then follows part ii. of the book, which is "practical," and occupies 224 pages. This is occupied wholly by constructions, and many of these constructions are to be taken in conjunction with corresponding theorems, to which the pupil is duly referred in part iii. of the book, which is "theoretical." It must not be supposed, however, that part ii. is merely constructive—that is, that the pupil is directed to perform certain operations without understanding the reason. The constructions are, almost invariably, accompanied by a justifying proof, and the whole collection seems to be exhaustive. Here the nature of an *envelope* is also explained, and a few examples of the drawing of envelopes are given.

Under the head of constructions we find also the definitions of the trigonometrical functions, and some constructions founded thereon, so far as one angle is concerned. There is also a section dealing with the displacement of a lamina in its own plane, and the nature of the instantaneous centre of rotation. It is needless to say that the plotting of figures on squared paper and the measurement of areas thereby occupy a fair space in this section. The principles of folding and superposition, also, are largely employed as a means of proof. There is no doubt that in this work of Messrs. Barnard and Child the teacher will find every requisite for the modern teaching of geometry, including a very large number of illustrative examples. The collection of all construction propositions into one large section by themselves is the main difference between the two works before us.

In the work of Messrs. Godfrey and Siddons the constructions appropriate to each branch of the subject form a special section in that branch; thus constructions relating solely to triangles are taken together in the part of the book dealing with congruent triangles, those relating to circles in the part dealing with circles.

There is a remarkable similarity of procedure in the theoretical or deductive portions of both works. Each begins with the discussion of angles at a point, then follow the treatment of parallel lines, angles of a triangle and external angles of a polygon, congruent triangles, inequalities (*i.e.* of sides and angles of a triangle) and parallelograms, closely followed in each work by the discussion of areas.

Messrs. Godfrey and Siddons adopt the invariable plan of accompanying each proposition with a large series of examples and applications. Sometimes we come across a well chosen practical example calculated to enlist the interest and sympathy of the young pupil—such as the application of a simple case of congruent triangles to the finding of the breadth of a river, of which a figure is given. The work is a charming one, marked by great simplicity.

Squared paper and the plotting of coordinates find also ample space in this book. Geometry is supposed to have arisen from the necessities of land-surveyors, but any such mundane connection has been so long severed that we find ourselves astonished when we actually see (p. 180) an irregular figure plotted and its area estimated by a process of give and take—and this in the midst of some of Euclid's propositions, too! Truly the times have altered rapidly—a still further

proof of which fact is furnished by the liberty which each of these excellent works takes with Euclid's Prop. 19, Bk. vi.—"similar triangles are to one another in the duplicate ratio of their homologous sides"—mysterious but high-sounding to countless generations of schoolboys. Here it is, in identical words in both books, "the ratio of the areas of similar triangles, or of two similar polygons, is equal to the ratio of the squares on corresponding sides," brought down to definiteness and intelligibility at last!

There are certain time-honoured propositions in the treatment of which teachers will take a special interest, and none more prominent than Euclid's Prop. 1 of Bk. vi. Messrs. Barnard and Child prove it by assuming that the bases of the triangles are multiples of some common length, while Messrs. Godfrey and Siddons (p. 175) treat it as a mere result of the fact that the area of a triangle is half the product of a base and the corresponding perpendicular—both proofs, of course, resting on the same ultimate assumption. In justification of such proofs it may be said that no useful purpose will be effected by an early discussion of incommensurable quantities.

There are many things—such, for example, as the constancy of the product of the radii vectores from a fixed point to a circle, the nature of a tangent as a limiting position of a chord, &c.—in which we have an agreeable and useful variety of treatment in these two works, but the limitation of space renders further reference to them here impossible.

G. M. MINCHIN.

"SEMI-DARWINIAN" SPECULATIONS.

Doubts about Darwinism. By a Semi-Darwinian. Pp. vi+115. (London: Longmans, Green and Co., 1903.) Price 3*s.* 6*d.*

THE preface of this work informs us that its author has endeavoured to conform strictly to the principle laid down by Lord Kelvin, as follows:—"If a probable solution, consistent with the ordinary course of nature, can be found, we must not invoke an abnormal act of Creative Power." Unfortunately the "Semi-Darwinian's" practice is not in accord with his profession. Whenever he meets with a problem in evolution which appears to him inexplicable on the lines of natural selection, so far from seeking for "a probable solution, consistent with the ordinary course of nature," he resorts at once to the intervention, by a direct creative act, of "a Being possessing intelligence, intention and power." This is bad science, and we much doubt whether it is good theology.

Opinions have differed, and will doubtless for a long time continue to differ, as to the extent of the influence of natural selection as a factor in evolution. Darwin himself, as is well known, thought that its operation might be supplemented by that of the factors adduced by Buffon and Lamarck. Whether in view of the increase of knowledge since Darwin's day, and of the numerous cases of difficulty which have lately been satisfactorily explained on the basis of natural selection, he would have been led to discard those hypotheses that involve the hereditary transmission of acquired characters, it is, of course, impossible to say. But it certainly seems probable to those workers in whom the Darwinian tradition is strongest that their leader, were he living now, would attribute more rather than less importance to his distinctive principle of natural selection. However this may be, the fact remains that if by "Darwinism" be meant the natural selection of "accidental" variations, the doubt as to its claim to be the sole factor in evolution is a doubt that was felt by Darwin himself. Hence we demur to the title of the present work.

A matter of greater importance is the author's attempted demonstration of the impossibility of explaining certain phenomena on Darwinian principles. It is true that some of the facts he adduces have been felt as difficulties, but not, as a rule, in the way that he supposes. To answer his objections point by point would be lost labour, for he shows on almost every page that he is unacquainted with the conditions of the problem. His remarks on the subject of vision, of reproduction, of embryology, to take a few instances, are those of a disputant who has entered the lists without the necessary equipment. Argument with such an opponent is unprofitable. As an example of the failure of the "Semi-Darwinian" to master the present-day aspects of the subject, we may take his treatment of the caterpillar and beetle-stabbing instincts of Sphex and some other genera of fossorial Hymenoptera. He quotes Romanes's expression of a desire for further investigation of the facts, but appears to be quite unaware that the need has been to a great extent supplied by the labours of two industrious and accurate naturalists in America, who have put an entirely new complexion on the case as it was known to Darwin. We have no wish to detract from the merits of so zealous and patient an observer as Fabre, to whose writings those who have discussed the habits of Sphex, Ammophila, and their allies have generally been indebted for their facts; but it is impossible to study the recent work on the subject without recognising that Fabre's inferences are sometimes unwarranted. Even before the new facts had been brought forward by G. and E. Peckham, the difficulties of explanation on the lines of natural selection, though great, did not seem insuperable; they may now be said to have disappeared.

But it is not only on such points of detail as the foregoing that the author shows his absence of qualification for dealing with the modern phases of the evolutionary problem. To say nothing of other omissions, the whole series of considerations specially associated with the names of Baldwin, Lloyd Morgan and Osborn is entirely ignored by him, nor does he give any sign of being acquainted with recent views on the subject of heredity. In short, as an attack on the adequacy of natural selection, his book, besides being ineffective, is hopelessly belated.

Supposing, however, that the author's strictures were well founded; that he had really contrived to point out certain stages in the evolutionary process which are not, and apparently never can be, explained on the basis of natural selection—what then? Surely in accordance with his own canon his next step should be to search for some other natural cause of the

phenomena that baffle him. To fly at once to the hypothesis of direct "intervention" by a "higher intelligence" is as much as to say that a science of life is impossible. It is not our province to enter into the theological aspects of the matter; we would only remark that the author's language on this head appears to us to be a curious instance of survival from a bygone epoch. When, as in the eighteenth century, deistic conceptions of nature were rife, the idea of "interference" or "intervention" rose easily enough in the minds of devout persons. The only alternative seemed to be the complete banishment of the Deity from his universe. But in so far as deism is discredited by evolution, its correlative notion of "interference" must share in that discredit; and it is, to say the least of it, somewhat surprising to find the idea revived in the supposed interests of religion by one who, like the "Semi-Darwinian," professes neither to "question the general doctrine of evolution" nor to "desire to disturb the position of the 'Origin of Species' as an epoch-making book." F. A. D.

WATER SUPPLY.

Water Supply. A Student's Handbook on the Conditions Governing the Selection of Sources and the Distribution of Water. By Reginald E. Middleton. Pp. ix+168. (London: Charles Griffin and Co., Ltd., 1903.) Price 8*s.* 6*d.* net.

THE provision of a pure and ample water supply is constantly growing in importance with the development of sanitary science and the rapid increase of the population in cities and large towns; whilst adequate and unpolluted sources of supply have to be sought at greater distances away, and in a country of limited area, such as England, will before very long become difficult to obtain, yielding sufficient quantities of water to meet the growing requirements of the inhabitants. Accordingly, water supply has within recent years become one of the most universally needed branches of engineering; whereas increasing difficulties are encountered in the execution of the requisite works. The enhanced value and interest thereby conferred on works providing supplies of water, have naturally led to the publication of several books on the subject in the last few years; but the present book differs from its more elaborate and comprehensive predecessors, in dealing with principles rather than with practice, and in being intended as a sort of introduction to those larger books, and for engineering students rather than for engineers.

The first introductory chapter gives a rapid sketch, within the limits of six pages, of the various points which have to be taken into consideration in devising a scheme of water supply, from the selection of a source to the delivery of the water to the consumer; and it provides a clear and useful summary of the questions which form the subjects of the succeeding chapters. The second and third chapters deal respectively with the requirements as to the quality and the quantity of water, the former describing the mineral and organic impurities liable to be found in water, the sources from which they are derived, and their relative importance; whilst the latter explains the variation in the daily consumption per head of population in different localities, under different conditions, at different seasons, and according to the amount of waste, also the provision necessary for increase in population, the method of measuring rainfall, the gauging of the discharge of streams and rivers, and the estimation of the available yield from the different sources of supply.

In the following chapter, on storage reservoirs, the form and construction of earthen dams, and the various arrangements resorted to for regulating the discharge of the water from the outlet of reservoirs, are the main subjects dealt with; and under the heading "Compensation Water," concluding the chapter, after explaining this important requirement, a description is somewhat irrelevantly added of the earthen embankments of the Staines reservoirs, with which the author is professionally connected, the only definite reference to an executed work given in the book. The next chapter is devoted to the calculations of stability of masonry dams by analytical methods, but a graphical treatment of the statical problems involved would be found both clearer and simpler. An interesting description is given in chapter vi. of the purification of water by the ordinary English system of slow filtration through sand; and a brief reference is made at the end of the chapter to the American system of rapid filtration by aid of a coagulant, usually aluminium sulphate, introduced into the water.

The construction of service reservoirs for providing against fluctuations in the consumption is considered in a short chapter; and it is followed by a fairly complete investigation of the flow of water through pipes, occupying twenty-seven pages. The last three of the eleven chapters in the book, relating to distribution systems, pumping machinery, and requirements in connection with waterworks, together covering less than nine pages, add more to the number of chapters and the apparent scope of the book than to actual information about waterworks, the last chapter, more particularly, consisting simply of an appeal for the collection of additional and more detailed statistics in regard to rainfall, evaporation, the discharge of rivers and streams, and other matters pertaining to water supply. The book is illustrated by four folding plates and sixty-six figures in the text, and a short index is added at the end.

Though some subjects, such as aqueducts from impounding reservoirs, water meters, and sections of typical masonry dams are not described, and the information about springs and wells is scanty, and the book, therefore, does not provide a complete account of waterworks, it gives a considerable amount of practical information, combined with valuable suggestions for the guidance of waterworks' engineers in several of the chapters. The way, however, in which the book is written renders it more likely to be used for reference than or reading straight through; and, moreover, the number of short paragraphs into which it is broken up, even when treating of a single subject, is calculated to distract the reader. Nevertheless, the engineering student will find a considerable store of useful information and valuable hints dispersed

throughout the book; and it should serve as a convenient guide for leading on students to the intelligent study of more complete and elaborate treatises on water supply.

THE MATHEMATICAL THEORY OF CRYSTAL STRUCTURE.

Mathematical Crystallography and the Theory of Groups of Movements. By Harold Hilton, M.A. Pp. xii+262; with 188 figures in the text. (Oxford: Clarendon Press, 1903.) Price 14*s.* net.

UNDER the fostering care of the energetic professor a small but vigorous school of mineralogy is growing up at Oxford. We are not surprised to note in the preface that it was due to Prof. Miers's suggestion that Mr. Hilton undertook the task which he has so successfully accomplished. Mr. Hilton has had a distinguished career at Oxford, and it is with pleasure we observe that a mathematician of his attainments has turned his attention to a subject which receives such scanty consideration in this country.

Mr. Hilton's book appears at an opportune moment, since it is the generally accepted idea that the geometrical theory of crystal structure has reached something like finality. A good historical account of the development of the subject is contained in the British Association Report, 1901, and the present work supplements that survey by supplying the detailed reasoning. The scope of the book is more restricted than the rather wide title would lead a reader to suppose, and it is almost wholly concerned with the symmetry and structure of crystals. With the exception of a few chapters, it follows closely Schönflies's "Krystallsysteme und Krystallstructur," but some features are introduced from the writings of Jordan, Fedorow and Barlow. Very slight allusion is made to Sohncke's work. We think it would have added to the value of the book had a page or two been devoted to his systems. Of course, they appear among the space-groups; but at the same time some Sohncke-system forms the basis of every space-group. This is Barlow's way of considering the subject, and may be found easier of comprehension by many readers, especially if the theory of groups be new to them. The book is distinguished by the fine series of diagrams of the space-groups, which have been drawn independently in the way suggested by Fedorow. The explanation of the figures, which is given on p. 171, might have been made more conspicuous so as to catch the eye more readily. The absence of such diagrams appreciably adds to the difficulty of understanding Schönflies's work.

Mr. Hilton divides his book into two parts. In the first he determines the thirty-two classes of centro-symmetry, which obey the law of rational indices and are therefore alone applicable to crystals. Another, and perhaps more logical method, is to assume that crystalline structure is cross-grained; that is to say, that a lower limit can be found to the distances between the elementary parts, whatever they may be. With this assumption, it may be shown that the only possible axes of symmetry have respectively 2-, 3-, 4- and 6-fold symmetry. The law of rational indices alone is not entirely satisfactory on account of a peculiar case of pseudotrigonal symmetry which in that way arises. This part includes an elaborate chapter on the coordinates of equivalent points, and a chapter of considerable interest on the growth of crystals.

The second part corresponds very closely to the second part of Schönflies's book. After determining the fourteen varieties of lattices, the author discusses the properties of geometrical operations and the infinite groups of movements. The dynamical flavour which unavoidably clings to the subject is unfortunate, and without a note of warning the reader may be misled into the idea that something in the nature of a movement does actually occur. On p. 159 the author proves the fundamental proposition connecting the space-groups with the corresponding point- and translation-groups, and in the succeeding six chapters he deduces the 230 space-groups belonging to the six systems. A chapter follows on the partitioning of space, with special reference to Schönflies's elementary cell.

In the next chapter, on crystal-molecules, mention is made of attempts that have been made to assign arrangements to particular substances. It may be noted that at the present day there is a tendency to regard the molecules which compose a crystal, or rather their spheres of influence, as being in contact. In that case Barlow's theory of closest-packing would have some justification. A brief historical sketch brings the book to a close.

Mr. Hilton has prepared a masterly exposition of a difficult subject, and we can heartily commend the book to the attention of crystallographers.

OUR BOOK SHELF.

Das Haar, die Haarkrankheiten, ihre Behandlung und die Haarpflege. By Dr. J. Pohl. Fifth revised and enlarged edition. Pp. 178. (Stuttgart: Deutsch Verlags Anst., 1902.)

THIS is a popular treatise upon a subject which has received too little attention from scientific observers. The first part of the work deals with the structure and development of the human hair, with a brief account of the methods of investigation. The author, with the painstaking thoroughness of the German savant, has made a large number of researches into the rate of growth and the normal fall of the hair. The common belief that cutting the hair promotes its growth is shown to be erroneous. Each hair has, on the average, a normal life of about seven years, at the end of which time it falls out and is replaced by a new one. In health there is a normal fall of hair which varies somewhat with the age of the individual.

The second part of the work is devoted to the diseases of the hair and their treatment, and to the care of the hair. The author considers that in most cases oil or pomade is beneficial, but he insists that the quantity applied must be small. The vexed question of washing the hair is discussed. In individuals in whom the scalp is healthy, Dr. Pohl is of opinion that too frequent washing is inadvisable. He advocates the use of bran, yolk of egg, and other demulcents in the water used. Rapid and thorough drying of the hair after washing is insisted upon, especially for ladies.

As an important cause of baldness in men, the author places the wearing of stiff and heavy hats, which for hours together compress the blood-vessels of the scalp and impair its nutrition and that of the hair. He points out that the common straw hat is often responsible for as much compression as the cylinder hat.

The part played by general organic and nervous diseases in causing baldness and premature greyness is considered, and these conditions obviously demand treatment at the hands of the physician. The *rôle* of micro-organisms in the production of baldness is perhaps insufficiently dealt with in the light of the work of Sabouraud and others in seborrhœa. Attention is, however, directed to the effects of the parasites of ringworm and favus. But in these diseases and in alopecia areata the patient will naturally seek medical advice.

Though the work is obviously written as a popular treatise, its perusal will be of value to the medical practitioner, who very rarely gives attention to the subject, which is one of great interest to the public, who are only too ready to fly to various nostrums brought to their attention by assiduous advertisement.

Radiant Energy. A Working Power in the Mechanism of the Universe. By R. W. O. Kestel. (Port Adelaide, 1898.)

THE loose and unscientific use of terms, such as force, the curious absence of ordinary mechanical conceptions, as, for example, inertia, and the almost puerile objections raised against the Newtonian theory of planetary motion, sufficiently proclaim this book to be the work of the untrained amateur with original ideas. In consequence, none but a discerning reader will profit by its perusal. Yet the closing sentence—"Radiant Energy is a Working Power in the Mechanism of the Universe"—is a remarkable one, considering that the book is dated as having been published five years ago. The researches of Nichols and Hull in America, and Lebedew in Russia, on the pressure due to radiation have established the author's contention. In the chapter on comets some of our present notions of the cause of comets' tails are clearly anticipated, but in applying the same idea to other parts of the mechanism of the universe, the author has fallen into the error of imagining a repulsion from the sun "just thirty thousand million times too large." The main idea is that "a repelling force radiating from the sun" "partakes of the sun's motion of rotation," and "is carried round in the direction the sun is revolving." The author justifies himself by mechanical analogies, and uses the idea to account for the origin of both the orbital and axial motions of the planets. By the aid of a model in which the repulsive force is represented by a stream of horizontal water jets emanating from a rotating nozzle, many of the phenomena of planetary motion, it is claimed, can be demonstrated experimentally. The idea, although so crudely expressed, when applied to our present knowledge does seem to possess a real value. Light, radiating from the sun, should, it seems, be affected by the rotation of the sun, in such a way that the resultant of the pressures from all parts of the solar surface which reach a planet passes through a point displaced from the centre in the direction of the edge approaching the planet. The same would apply to pressure exerted by normally projected corpuscles or electrons. The effect is to produce a positive acceleration of the planet in its orbit. Whether there is also a couple acting to produce rotation suggests a nice problem for the astronomer. Is it possible that these infinitesimal pressures acting over infinite time could originate the motions of the planets? Could these pressures maintain the planet in uniform motion through a resisting ether? These problems should now admit of a definite answer, and seem worthy of a more competent analysis than the reviewer is able to give. F. S.

Physikalisch-chemische Theorien. Von A. Reychler, nach der dritten Auflage des Originals bearbeitet von B. Kühn. Pp. xii+380. (Braunschweig: Vieweg und Sohn, 1903.) Price 9 marks.

FOR its compass this volume contains a wonderful amount of well-arranged material. It covers the ground usual in elementary works on physical chemistry, but by concise treatment of descriptive and theoretical matter the author finds room for much detail that has no place in other books of equal size. This gives it considerable value as an elementary work of reference, whilst it rather detracts from its suitability to the needs of the beginner.

What will probably render the book most interesting to English readers is the substitution by the author of a peculiar hypothesis of hydrolytic dissociation for Arrhenius's hypothesis of electrolytic dissociation, which, however, is duly expounded in its place. The author conceives that when a salt is dissolved in water it dissociates into the corresponding acid and base, the degree of dissociation being presumably equal to that attributed to the salt by Arrhenius's theory. The behaviour of acids and bases themselves is explained by an auxiliary hypothesis which postulates the separation from the total solvent water of a special kind of water molecule which cannot pass an osmotic membrane permeable to the other water molecules. Unfortunately the author makes no attempt to carry out his theory in detail, and so the reader is left in a somewhat dubious state of mind regarding its merits.

The author reproduces on p. 78 Traube's erroneous deduction of the degree of association of a liquid from the results of the volume method. A glance at the formula shows that it is only correct when $x=1$ or $x=2$, and is erroneous for all intermediate values.

Electrical Engineering Measuring Instruments. By G. D. Aspinall Parr. Pp. viii+328. (London: Blackie and Son, Ltd., 1903.) Price 9*s.* net.

MR. ASPINALL PARR has aimed at giving a description of all the leading electrical measuring instruments on the market, and he has carried out this object with a painstaking thoroughness worthy of a better cause. There can be few instruments enjoying any respectable sale which are not included in this book, and the descriptions are exceedingly clear; so also are the illustrations of the working parts, yet the reader gains little more from the book than he could gain, with perhaps a trifle more trouble, from a perusal of the makers' catalogues. "Fig. 70," to quote from the book, "shows the general appearance of this instrument with the index pointer set to 102 and the pointer clamped at zero," and Fig. 70—a picture of a brass case and a paper scale—is typical of quite 50 per cent. of the 370 excellently reproduced illustrations. The importance of instruments to electrical engineers is not to be underrated, and it is quite true, as the author says in his preface, that the literature of the subject has been neglected. But the literature that is needed is not a collation of catalogues, but something that may guide the purchaser in selecting an instrument suited to his purpose. Mr. Parr makes a point of having avoided comparison, yet this is the very thing that is wanted; in many cases one can form no idea whether the instrument is suited for high or low voltages, for large or small currents, what is its accuracy under different conditions, or what even is the general accuracy obtainable with instruments of a

given type. There is a general discussion of the theory of each class of instrument, but this is of too fragmentary a nature to be of value; we may direct attention to the fact that the discussion of hot-wire instruments is incorrect; no mention is made of the cooling of the wire, and it is apparently assumed that the instrument is kept in the circuit for exactly one second whenever a measurement is made.

It is a pity, seeing how much trouble has been taken with the drawings of the working parts and the wide acquaintance with instruments which is evidenced, that Mr. Parr has not given us a more valuable work. As it is, the book may prove useful to those who may be called upon at any time to put something right in an instrument which has broken down. M. S.

Life in Mind and Conduct: Studies of Organic in Human Nature. By Henry Maudsley, M.D. Pp. xv+444. (London: Macmillan and Co., Ltd., 1902.) Price 10*s.* 6*d.* net.

READERS of Dr. Maudsley's former volumes will find in the present work both the faults and the merits of its predecessors. Dr. Maudsley here, as always, writes with a great deal of epigrammatic felicity, and shows from time to time vivid flashes of insight into human character; here, too, as formerly, he often mars the effect of his epigrams by a tendency to re-elaborate them into rhetorical "common-places," in the technical sense of the term. The fundamental positions of the book may be reduced to three: the worlds of mind and of matter in reality form a single continuous evolution; "whatever is, is right," being an inevitable result of the laws of that evolution; "private vices" are, as Mandeville taught, "public benefits," inasmuch as vice and virtue are alike expressions of the needs of the "social organism." On this last topic Dr. Maudsley writes a great deal that is striking and not a little that is true, but he never explains how upon his principles the recognition of *any* distinction between right and wrong can be other than an absurdity. If the whole of morality is devotion to the advancement of society, and if, again, the advancement of society is *equally* promoted by virtue and by crime (and this is what Dr. Maudsley more than once asserts), why should we make any distinction between the hero and the criminal? That God brings good out of evil is a truism; it does not follow that the evil is therefore as good as the good. A. E. T.

Elementary Bacteriology. By M. L. Dhingra, M.D., C.M., Edin., D.P.H., Camb. Pp. xiv + 145. (London: Longmans, Green and Co., 1903.) Price 3*s.* net.

FROM the preface we learn that this little book has been written especially for Indian students and practitioners. Too much has been attempted in the space, and the descriptions suffer from extreme brevity, only the fringe of the various subjects dealt with being reached. For example, no less than sixteen disease conditions are discussed in about forty pages, excluding the space allotted to illustrations, &c. The information given, so far as it goes, is as a rule accurate, the introductory portion upon the morphology and general biology of the bacteria being perhaps the most satisfactory. Subjects of especial interest to the Indian practitioner, *e.g.* protective inoculation against cholera, receive little more attention than many others which only indirectly concern him; actinomycosis is allotted more than a page, madura disease less than half a page. In the concluding portions of the book immunity, the principles of bacteriological technique, and antivenene are similarly dealt with. The book is well and sufficiently illustrated. R. T. HEWLETT.

LETTERS TO THE EDITOR.

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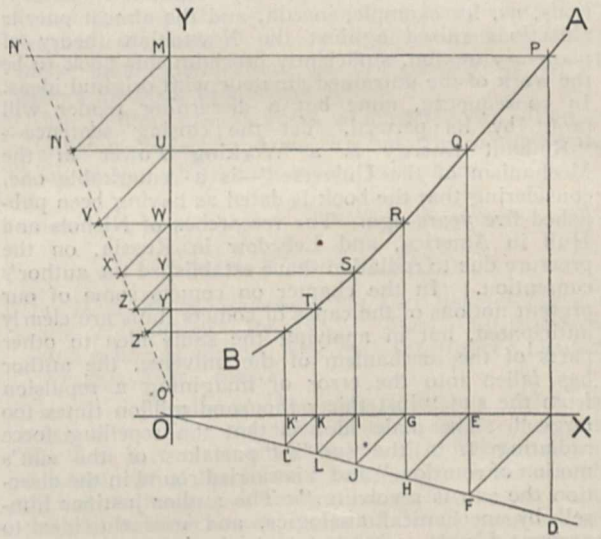
A Useful Empirical Formula.

MY note in NATURE of October 8 may be extended. I found that one of my pupils, Mr. Glasgow, was assuming that the expansion and compression parts of a gas engine diagram followed laws of the type pv^n constant; in cases where there was a probability that the clearance had not been measured accurately, so that v being the measured volume and c the constant error, he assumed $p(v+c)^n$ to be constant, and he was enabled to find c from the curve. There is no reason to believe that these curves ought to have such a law, although, curiously enough, following this assumption, the clearance obtained from the compression curve is usually not very different from that obtained from the expansion curve. Mr. Glasgow's method of finding c is much the same as what I shall now describe. An empirical formula of the type

$$y = a + bx^n$$

would be exceedingly useful in many parts of pure and applied science if, when given a table of values of y and x, we could readily find a, b and n. I have often sought for a method of working, but without success. If a is zero, we have only to plot log y and log x as the coordinates of points on squared paper. If a is not zero, there is a clumsy method of using logarithmic paper which may be adopted,



but it is not satisfactory. We now have a method easy of application. Thus values of x and y being given, draw the curve AB shown in the figure. Set off any convenient angle DOX. Select the point P. Draw PD, XF, FEQ, EH, &c., the lines XF, EH, &c., being at 45°. Project horizontally from the points PQR, &c., to M, U or N, W or V, &c., letting lines at 45° from M, U, &c., meet the horizontals at N, V, X, &c. If the above law holds, N, V, X, Z lie in a straight line. If they lie only approximately in a straight line, draw the line N′O′ lying most evenly among them. Then OO′ is the value of a, and n is

$$\log (1+\tan \mathrm{N'O'Y})/\log (1+\tan \mathrm{DOX}),$$

and b is readily found.

I may say that we have no great difficulty in testing whether a curve follows approximately a law like

$$y - \alpha = b(x-\beta)^n.$$

For this we have the curve on *tracing* paper, and we try as in the figure, then slide the curve a short distance in the direction x and try again, and so on. After a little study Mr. Glasgow has discovered a number of interesting properties of curves of these types. JOHN PERRY.

A Simple Lecture Experiment with Radium Rays.

WHILST preparing some experiments for a lecture on this matter, I found a very simple device to demonstrate the important fact that radium rays are very easily transmitted through a high vacuum; and I am not aware that it has been published before in this way. I had at my disposal the strongly acting compound of radium bromide which is prepared at Brunswick, in Germany; 10 mgr. were enclosed in a small box of ebonite with a mica cover having a diameter of 20 mm. This was put down in a Dewar's tube with vacuum jacket, as is commonly used in experiments with liquid air, and held in place by a stopper of cotton wool. The tube was then turned upside down in a little dish with some mercury, so as to obtain a perfectly enclosed space, and the radium rays could only get out by the vacuum walls or through a thick layer of mercury; by taking enough of this dense liquid the escape may be stopped altogether. Putting now a charged sensitive gold leaf electroscope at a distance of 5 cm. from the tube, a leakage instantly sets in, so as to cause the instrument to be wholly discharged in fifteen seconds. I also tried a vacuum jacketed tube with silvered walls, but though this affords much better protection against the heat rays, I did not detect any considerable difference with regard to the former experiment; the discharge was almost as quick, demonstrating that radium rays are not reflected to an appreciable amount. Even when the radium bromide was put into a large Dewar's silvered balloon of 5 litres capacity, wrapped in cotton wool, and enclosed in a wooden case, in which liquid air would be preserved during more than a fortnight, the charged electroscope came to zero in half a minute when it was placed very near to it. The experiments are effective and easily arranged. L. BLEEKRODE.

The Hague, November 20.

Nuclei and Ions

IT is perhaps ungracious to reply to a review. I appreciate very fully that in cases of papers like mine, which take an isolated position and are written by a man who is not infallible, the task of the reviewer is burdensome enough. But Mr. C. T. R. Wilson's summary of several years of my work (October 8, p. 548) seems to me unnecessarily captious, and I am obliged to answer in self-defence.

I will not quarrel with Mr. Wilson about the titles of my papers, or about references to my first paper ("Experiments with Ionised Air"). I have had occasion to come back to it myself since (*Amer. Jour. Sci.*, xv., 105; *ibid.*, 217), and shall presumably do so again.

Turning to the second paper ("Structure of the Nucleus"), the impression given is that my first chapter is superfluous. The particular direction in which Mr. Wilson thinks it superfluous, *i.e.* the determination of reciprocal relations in the number of ions and nuclei arising in any process, I consider of special importance, as I shall explain below. Apart from this, the gist of the chapter is the (to me) very interesting result that phosphorus as a nucleator suddenly bursts forth into maximum activity at about 13°. The smoke at higher temperatures is a degradation. If I had made these experiments earlier I should not have drawn the comparison between the number of nuclei and the number of ions which Mr. Wilson impales. Recently (*Amer. Jour. Sci.*, xv., 217) I have departed widely from this early result.

With regard to my work on coronas, I had hoped that any rational attempt at systematisation would at least be tolerated. It was something, I thought, to plough through so bewildering a display and to get the general lay of the land in that deceptive colour territory, to distinguish sharply between the axial and the coronal colours, to ascertain that even in the former case the particles are large in comparison with the wave-length of light. So far as I know a discrimination of the evidence obtainable from the steam jet and the condensation chamber has thus for the first time been given. Mr. Wilson, however, has no encouragement. He gravely doubts "whether the method can be made a trustworthy one." Unfortunately I did not know this, for I have since ventured to repeat the whole work (*Amer. Jour. Sci.*, xvi., 325, and a forthcoming paper in Boltzmann's "Jubelband"), with corrections of method and calculations, obtaining suggestive periodic variations of the coronal apertures for a given colour and the sizes of the cloud particles. I have recently succeeded in catching, holding, and approximately measuring under the microscope the particles of the finest fog (beyond the largest green-blue-purple corona). Again, in a year's continuous observation by my coronal method of the atmospheric nucleation of Providence (lest this lead to "misconception," let me say that no theological bearing is implied), I have found the data useful (*Physical Review*, xvi., 193; xvii., 233).

My interpretation of the experiments on the diffusion of the nucleus is in error, but I have long since corrected it (fully in *Amer. Jour. Sci.*, June, p. 472, briefly in *Drude's Annalen*, August, p. 1144). Hence I do not find Mr. Wilson's belated comments particularly helpful. I was so fully convinced that the excessively slow diffusions observed could only be due to the motion of nuclei that I failed to see that the small coefficients of the hydrocarbon vapours would be virtually accentuated in large degree by the occurrence of diffusion from saturated to somewhat less saturated vapour. But this bad break is not of primary significance in its bearing on my work; the original purpose of these experiments with hydrocarbon vapours, which Mr. Wilson overlooks, was this:—If the ionisation accompanying nucleation is favourable to condensation, it should be particularly so, presumably, in the case of the vapour of an ionising solvent like water. Hence if non-ionising solvents like the hydrocarbons be substituted for water, the absence of effects attributable to ionisation might be discernible. No essential difference was detected.

In the following remarks relative to nuclei produced by shaking liquids, it is astonishing to find a faint note of approval, but Mr. Wilson does not intend that it shall be taken too seriously. "There is nothing new," he hastens to add, "that nuclei of this kind exist." Verbally, this may be true, but the implication of the whole paragraph is much broader. He does not point out, however, where I may find a prior succinct statement, identical with the view which I give for the persistence of the solutional nucleus.

My "extraordinary hypothesis," as Mr. Wilson calls it, is a critical alternative, put forward to ascertain whether it has been proved that ionisation has an immediate effect on condensation, or whether such condensation is not even now to be regarded as a mere question of the size of the nuclei. The hypothesis should, in the first place, be fairly stated. In any region of intense ionisation there must be a correspondingly marked tendency to synthesis. The nucleus is the stable result of this synthesis. What its structure is to be depends, therefore, primarily on the chemical ingredients of the medium out of which the nucleus is made. Given a definite medium, simple or complex, and one may anticipate a nucleus of definite size and a corresponding supersaturation needed for condensation. My contention is, then, that if nuclei are formed by the X-rays at the anode and the kathode, they are liable to be different, because the ingredients out of which the nuclei are to be compounded are different. If they do not vary in size but merely in number with the intensity of the radiation, this need be no more surprising than that the products of combustion remain the same within a wide range of temperature.

My reasons for this view may best be developed in connection with the case of phosphorus. Mr. Wilson dismisses it by stating, "The answer is simply that the nuclei causing the phosphorus clouds are not free ions like those produced by the X-rays." Let me explain why I fail to grasp the term "free ion." The phosphorus nucleus, as experiment shows, is always a relatively persistent body, while the initial ionisation is to an equal degree characteristically fleeting. Usually before the emanation has been made available for condensation, only a few per cent. of the initial ionisation is left. Meanwhile, the nucleation or condensational activity has suffered no commensurate decline (*Physical Review*, xvi., 288). It is probable that the whole series of condensations subsequently to be evoked follow in the absence of ionisation.

The case of water nuclei is in this respect almost the same, except that the initial ionisation (I shall venture to call it so, since it discharges both positive and negative

electrification; *cf. Amer. Jour. Sci.*, xv., 105) is rarely neutral as a whole. But it vanishes almost completely while the number of nuclei is relatively constant. In general, diminutions which are questions of seconds or minutes with the ions are more than questions of hours with the nuclei.

Just as in these cases there is no marked decrease of the number of nuclei while the ions all but go, so I have been unable to find any contemporaneous increase of number; and yet in my experiments with phosphorus and with water nuclei the activities of any generator for the simultaneous production of nuclei and of ions seem to increase and decrease together. I shall be able to state this more definitely at the conclusion of my present experiments on the efficiency of different types of water jets.

Finally, in my "Experiments with Ionised Air" (p. 12), I showed that in case of tests made with the steam jet, nuclei produced by the X-rays in atmospheric air were persistent in like degree with phosphorus and other nuclei. In fact, there was little difference in this respect among the nuclei examined. Nuclei produced in dust-free air, saturated either with water vapour or with hydrocarbon vapour, by the X-rays acting from without, retain the same order of persistence, whereas the ionisation is known to be fleeting. True, rubber stoppers and tubes made up a part of my condensation chamber, but in the case of water nuclei, at least, I can see no objection to this. The entire absence of electric field is always understood.

In all cases, therefore, the electrification vanishes and leaves a nucleus behind, sometimes larger, sometimes smaller. If, in any one of them, the nucleation and the ionisation vanished at the same rate, the case would be good presumptive evidence of their identity. But, to my knowledge, never does this occur. What justification is there, then, to call the phosphorus nucleus an "oxide," or if an oxide associated with ionised air, why does one not find the smaller air nuclei? I should answer that the phosphorus nucleus is the stable product of the initially ionised field. Again, why is phosphorus and dry air a more complicated system than air and water vapour under the action of the X-rays? *Out of both systems* eventually issues a stable nucleation. And why may one attribute to ionised air different condensational properties, according as positive or as negative ions are in question, without having first established that the corresponding air nuclei do not differ in size sufficiently to account for the condensational difference observed? Why may one condense on a nucleus from which the soul has fled and still be permitted to call it an ion? Why, indeed, does the nucleus persist after the ionisation has vanished; why does one not get back to dust-free air? My answer would be as in the case of phosphorus. As to water nuclei, I am much in doubt ever since I have been able to arrest the finest fog particles for examination whether the nucleus from shattered water is mere water dust. It seems to me, therefore, that electrification, if present simultaneously with nucleation, is an incidental accompaniment with no immediate bearing on the condensation produced, and for this reason I have in the above endeavoured to account for the nucleus at the outset chemically. CARL BARUS.

Brown University, Providence, U.S.A.

I DO not think that any worker with ions or with condensation nuclei who may have read the papers on "Experiments with Ionised Air" and on "The Structure of the Nucleus" will consider my criticism unjust.

The latter part of the letter requires some reply. According to Prof. Barus, in all cases studied by him the nuclei were distinct from the ions, persisting long after the ionisation had disappeared. All that this proves is that he has not yet succeeded in observing condensation upon the ions, but only upon nuclei of another kind. According to my experiments (*Phil. Trans.*, vol. cxciii. pp. 289–308, 1899), a fourfold supersaturation is required to cause condensation on the negative ions, a sixfold being required for the positive ions. To get such high supersaturations as these an exceedingly rapid expansion is required, and it is probable that the apparatus used by Prof. Barus is unsuitable for the purpose. In the presence of any considerable number of nuclei requiring inappreciable supersaturation (as persistent nuclei always do) to cause water to condense upon them, it must be particularly difficult to reach the supersaturation necessary for condensation upon the ions. Such persistent nuclei always were present in Prof. Barus's experiments; his failure to get condensation upon the ions was thus to be expected. His results have no bearing, therefore, upon the interpretation of my experiments on the action of the ions produced by X-rays and similar agents on condensation (for in these experiments nuclei more persistent than the ions were absent), nor of the experiments upon the charge carried by the ions made by Prof. J. J. Thomson (*Phil. Mag.*, vol. xlvi. p. 528, 1898, and vol. v. p. 346, 1903) and by Dr. H. A. Wilson (*Phil. Mag.*, vol. v. p. 429, 1903) with the same form of rapid-expansion apparatus as was used by me.

I have never been able to produce by the action of X-rays nuclei other than the ions, but possibly very intense radiation may do so, as ultra-violet light certainly does.

C. T. R. WILSON.

Cavendish Laboratory, November 23.

Weather Changes and the Appearance of Scum on Ponds.

SOME experiments which I have been making during the last year seem to bear very directly upon the interesting phenomenon described by "Platanus orientalis" in your issue of November 5. These experiments show that numerous solid substances suspended or dissolved in water have, by virtue of their surface-tension relations, a marked tendency to accumulate at any surface separating water from gas (*vide Proc.* Roy. Soc., August). Hence, by merely passing a stream of air-bubbles through solutions or suspensions of certain solids in water, it is possible to effect a considerable concentration of the dissolved or suspended solid in the upper layers of the liquid. Each bubble carries with it to the surface a load of solid particles, and leaves many of them floating there either as an ultra-microscopic "pellicle" or as a visible "scum." If a bubble is very minute, its load may be so great in relation to its volume that it may be entirely unable to rise, or may even sink. If, in these circumstances, the barometric pressure be diminished, the volume of the bubble increases in greater proportion than the surface-area, and therefore than the maximum load, with the result that numerous bubbles previously unable to ascend at once begin to rise towards the surface. If, during their ascent, the barometric pressure be sufficiently increased, at once they sink. If a vessel of water containing a sediment of sulphur or calcium soap, &c., be exposed to a sufficiently diminished air-pressure, the whole of the sediment will be seen to rise to the surface, the minute air-bubbles with their coating of solid acting like so many "Cartesian Divers."

In every ordinary pond gas-bubbles of various kinds are constantly being formed by the action of micro-organisms; in nearly every pond various solid substances, both organic and inorganic, possessing the required surface-tension relations, are present both in the mud and in suspension The gas liberated will be constantly bringing scum-forming material to the surface, whether it rises in large masses or in small bubbles. Either a fall in the barometric pressure, or a rise in temperature, or an increase in the activity of the gas-producing organisms should therefore result in increase of the scum. It must, however, frequently happen that the scum is swept to one side by the wind or sunk by various mechanical disturbances.

It would be extremely interesting to learn whether by "decided change in the weather" your correspondent means a change attended by a falling barometer.

Pembroke College, Oxford. W. RAMSDEN.

The "Affenspalte" in Human Brains.

WILL you kindly allow me the privilege of using your columns for the following note? In a recent number of the *Anatomischer Anzeiger* Prof. Elliott Smith published a most interesting forecast of an extensive work which he has in hand, dealing particularly with the occurrence in human brains of an occipital operculum; this occurrence had been considered previously as very exceptional, but Prof. Elliott Smith is able to show that this is far from being the case.

The presence of such an occipital operculum implies the existence, in the cerebral hemisphere possessing it, of a sulcus, called by Prof. Elliott Smith the sulcus lunatus, which is strictly comparable to, if not absolutely identical with, the "Affenspalte" so typical of the brains of Simiidæ and Cercopithecidæ.

The examination of cerebral hemispheres of representatives of the lower human races is naturally suggested, and the aborigines of Australia, from several points of view, seem particularly appropriate in this connection. Following up Prof. Elliott Smith's suggestion, I have examined the brains of the aboriginal natives of Australia in the Cambridge Anatomical Museum. As a result, four out of eight hemispheres show plainly the sulcus lunatus and occipital operculum. In one case only is the condition symmetrical in the two hemispheres. The smallest brain of the four bears a sulcus lunatus and operculum on one hemisphere only. Where the sulcus lunatus is interrupted, compensation seems to be provided by deepening of the inferior occipital sulcus.

A Chinese brain in my possession has in each hemisphere a sulcus lunatus.

I shall be much obliged if you can kindly place these observations on record. W. L. H. DUCKWORTH.

November 27.

The Rate of Nerve Impulses.

DR. ALCOCK, in his recent paper at the Royal Society, finds the rate of transmission of nerve impulses in man to be 66 metres per second. Sir Michael Foster, in his "Physiology" (1888, part i. p. 76), gives it as 33 metres per second. The difference is considerable, and places us in a dilemma :—(1) either Sir Michael Foster or Dr. Alcock is widely wrong; or (2) the rate of transmission has become greatly accelerated during the last fifteen years. Of the two, the latter seems to me the simpler explanation.

W. R. GOWERS.

The Leonids of 1903.

OBSERVATIONS were begun on November 15 at 17h. 57m. and continued until daylight rendered further watching useless. In the first five and a half minutes twenty meteors appeared, all but two of which were Leonids, so that the hourly rate of the latter was 200. This period seems to have been about the time of maximum, judging from the results of other observers. Shooting stars now began to diminish in frequency, as the sky was brightening as day approached, but in the half hour comprised between 17h. 57m. and 18h. 35m. (deducting time spent in recording) thirty-six were seen, thirty-four being Leonids. Beyond 18h. 35m. the twilight was too strong to expect to detect meteors, and though the look-out was continued until 18h. 57m. no more appeared.

The display was certainly very fine, Leonids shooting one after the other in various parts of the heavens, the effect being heightened by the crescent moon and Venus, shining resplendently side by side in the south-east. Most of them were bright, the average magnitude being 1 or a little greater. As is usual with the meteors of this shower, they moved swiftly and left streaks. The prevailing colours were blue and yellow.

The radiant point, as indicated by ten registered paths, was at 148°+22°.

The chief observed Leonids were :—

November 15.

Time h. m.	From	To	Mag.
18 7½ ...	139¼ − 6 ...	138 − 9 ...	>1
18 10½ ...	174 +20⅓ ...	179½+19¾ ...	=1
18 20 ...	110 + 9 ...	106½+ 7 ...	>Sirius
18 34½ ...	139½+33½ ...	132½+38½ ...	=♀

On the following night the sky was watched from 12h. 10m. to 14h., but though it was clear most of the time, only two Leonids were observed, and meteors generally were scarce. On November 18, from 18h. 5m. to 18h. 20m. no shooting stars appeared.

These two latter watches bring out an important fact, namely, that the shower very rapidly declined in strength after the maximum had been passed.

Sheffield, November 27. ALPHONSO KING.

ACCOMMODATION OF SCOTTISH SCIENTIFIC SOCIETIES.

IN response to a requisition signed by seven fellows, a special meeting of the Royal Society of Edinburgh was held on the afternoon of Thursday, November 26. There was a large attendance. The president, Lord Kelvin, occupied the chair; and Sir John Murray, seconded by Dr. John Horne, moved the following resolution, that

"This meeting of the Fellows of the Royal Society resolves to instruct the council to enter into formal communication with the other scientific societies having their headquarters in Edinburgh with the view of concerting measures for obtaining the use of the Royal Institution building wholly and exclusively for Scottish scientific societies."

The resolution was also supported by Prof. Cossar Ewart, Prof. Chiene, Dr. Munro, Dr. Buchan, Prof. Hudson Beare, Sir James Russell, and Prof. Chrystal. The last named, in his official capacity as secretary, referred to the history of the relation between the society and the Board of Manufactures for Scotland; while most of the other speakers spoke from the point of view of the various other societies of which they were members, such as the Royal Scottish Geographical Society, the Royal Society of Arts, the Meteorological Society, the Royal Physical Society, the Geological Society, the Mathematical Society, &c.

All who spoke were unanimous in their opinion as to the importance of the scientific societies having their rooms and libraries in one building. The advantages of such a combination are evident to all interested in the progress of science, and need not be enlarged on in these pages. But there are features peculiar to the present movement which deserve to be widely known. These were touched upon and in many cases emphasised by Sir John Murray and those who supported him.

One of the most striking architectural ornaments in Princes Street is the Royal Institution, erected in 1828. The Royal Society has always occupied the west wing of the building, and the rest is at present mainly devoted to art in the form of a statue gallery and schools of art. Several rooms are used by the officials of the Board of Manufactures, the reorganisation of which forms the subject of an important report recently made by a departmental committee specially appointed. So far as this report has to do with the Royal Society, it is in practical agreement with the claims advanced by that body, as given in the evidence of the secretary, Prof. Chrystal. These were that the society should have increased accommodation for its growing library, and should sit rent free and in perpetuity. It was pointed out by witness after witness before the committee that the building is unsuitable for art, and the committee accordingly recommends the construction of a new building for national galleries and art schools. Should the people of Scotland carry this recommendation into effect, the representatives of art will evacuate the Royal Institution, and the question will arise as to the best use to be made of the rooms. The Royal Society cannot effectively occupy the whole building, and it is under these conditions that Sir John Murray brings forward his plan for the concentration of scientific effort in the capital of Scotland. Very little internal change in the building would make it suitable for the purpose, and there is a large central hall which would serve admirably for scientific meetings of wider scope or of a popular character.

An "equivalent grant" to Scotland of 2000*l.* dates from the Union of the Parliaments, and the Board of Manufactures was appointed shortly after that time to

manage this grant and perform other incidental duties. At first this grant was devoted to the encouragement of woollen and linen manufactures, and of fisheries. Grants have also been made for scientific purposes; but latterly the money has been expended in the interests of archæology and art. In his evidence before the departmental committee, Sir Francis Mowat said that the treasury would gladly give 40,000*l.* in lieu of the 2000*l.* a year. This offer, Sir John Murray thought, should be accepted at once; for it is this 2000*l.* a year (from which science now gets no aid), which has again and again stood in the way of Scotland getting on the estimates for any scientific purpose. Were this done, the 40,000*l.*, together with other funds which have accumulated from the 2000*l.* and are now in the possession of the Board of Manufactures, could be used for building a national gallery and school of art. Although part of this sum should rightly be devoted to science, Sir John Murray was sure that all scientific men would willingly give up this right if they obtained the present Royal Institution building for their various societies.

There is not the least doubt that such a scheme would economise scientific effort, encourage scientific research, and make possible that unity and solidarity of action which is all important whenever any general scientific object is aimed at. C. G. K.

SOME ILLUSTRATIONS OF THE MINUTE IN NATURE.[1]

THIS book is intended to bring a somewhat technical and special subject, but one of great beauty and interest, directly before the general reader. The author dissociates his subject from all scientific methods and processes, and even from the instruments by which the work is done, and is content to direct the reader of fair intelligence simply to results. These are on the whole fairly selected, and presented, pictorially and descriptively, with ability. It is not a

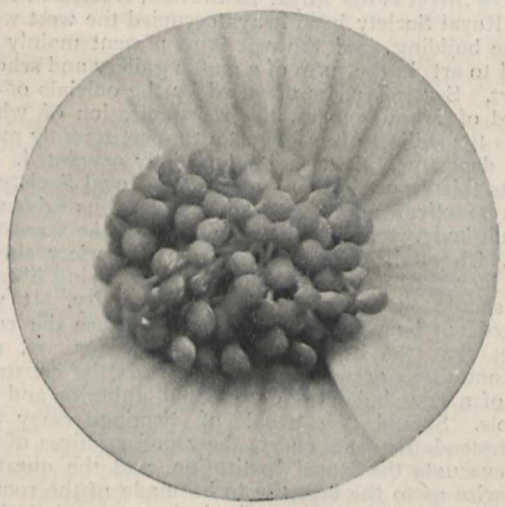


FIG. 1.—The Central Portion of a Male Begonia Flower. From "Minute Marvels of Nature," by J. J. Ward.

book for microscopical workers, however elementary, for it is a mere selection of objects likely to awaken interest in minds unfamiliar with the minute in nature. As might be anticipated, it is only low and moderate magnifying power that is employed in these "revelations," but the photomicrographs are good, and give correct impressions of the objects to those who have never seen them, or are unfamiliar with the use of lenses in the study of nature.

A great deal of space and labour is spent in dealing with the beginnings of plant life and the internal

FIG 2.—Pollen-grains falling from the Stamens of one of the Mallow Flowers (magnified). From "Minute Marvels of Nature," by J. J. Ward.

structure of plants. The illustrations devoted to the former purpose are not always competent, as that on p. 16 shows, which was intended to give an illustration of diatoms in their natural state. To a reader having no idea of what diatoms are, no enlightenment can be obtained from this photomicrograph. Many of the illustrations of diatoms are well done, and it is not at all probable that the reader will obtain from any other source photographs of the elaborate artificial arrangement of diatoms in geometric designs as they are given in this book.

The photographs illustrating plant structure are admirable, and will undoubtedly appeal to the general reader, and at the same time do much to awaken his interest in the hidden things that the microscope so readily reveals.

There is a good chapter, well illustrated, on pollen or flower dust, while some admirable illustrations and instructive writing are given the reader on the subject of insects' eggs. Some of these illustrations are of the first quality, but more care and detail would have greatly enhanced the usefulness of others of no little value in the efficient illustration of the subject. We may specialise Figs. 87 and 89, which were either inefficient photomicrographs or else processed so badly as to have made rejection a necessity. The figure giving the eggs of the small copper butterfly is excellent.

[1] "Minute Marvels of Nature," being some revelations of the microscope exhibited by photomicrographs taken by the author, John J. Ward. Pp. xxiv+272. (London: Isbister and Co., Ltd., 1903.) Price 7*s.* 6*d.*

The chapter on animal parasites is of interest, and will be eagerly perused by those for whom this book is written; so will the illustrations and descriptions of insect weapons and tools, although this chapter might with great ease have been made more popular by many added illustrations from familiar sources.

The book is well printed on good paper and admirably bound. It would make a useful and desirable present, and will, we believe, be read with pleasure by the general public, who will find that it opens a new world of facts and suggestions to them. D.

M. TSYBIKOFF'S JOURNEY TO LHASSA.

IN the latest number of the *Izvestia* of the Russian Geographical Society (1903, iii.) there is a very interesting paper, by M. G. Ts. Tsybikoff, on his journey to Central Tibet and his stay at the city of the Dalai-lama, Lhassa, the unattained goal of so many European travellers. M. Tsybikoff is a Russian Buryate by birth, and a Lamaite by religion, who studied at the Oriental faculty of a Russian university, and after having carefully prepared himself for this journey went to Tibet, as so many Buryate pilgrims do. He stayed on his way through Mongolia in two of the most renowned Mongolian monasteries, and on August 1, 1900, entered the holy precincts of Central Tibet without any difficulty. It was on the northern slope of the Bumza Pass, on the San-chu River. From this spot the caravan travelled south-westwards through the broad and open, extremely high and dry valleys of Central Tibet, where cereals are nevertheless grown by means of irrigation, and on August 16 they entered the holy city, after a three months' journey from the Gumbum Monastery, and a 370 miles' journey through Tibet proper.

At Lhassa M. Tsybikoff stayed more than twelve months, until September 23, 1901, and from that city he made an excursion so far as Tsetan, or Chetan, visiting, besides the three great monasteries situated round Lhassa—Braibun (8500 monks), Sera (5000 monks) and Galdan (2000 to 2500 monks)—also the monasteries of Dashi-lhunbo (170 miles from Lhassa, on the right bank of the Brahmaputra) and Sam-yai, on the left bank of the same river, about 67 miles south-east of Lhassa, one of the oldest in Tibet, as it was founded in the ninth century. He also visited the towns Shiha-tse, Chan-tse, and Tsetan.

The descriptions which the Russian traveller gives of Lhassa and its sanctuaries, as well as of the monasteries already mentioned, the population, its composition and its ways of living, the Government and administration, and the climate of the country—meteorological observations were made thrice a day without interruption for 235 days—are extremely interesting. The estimates of population hitherto given have been very much exaggerated, and M. Tsybikoff takes the number as not exceeding two and a half millions, out of whom one million are living in the two provinces U and Tsan. Lhassa has no more than 10,000 inhabitants, two-thirds of whom are women, its population having been overestimated on account of the 15,000 to 16,000 monks staying in the three above-named monasteries and the numbers of pilgrims.

During his stay at Lhassa M. Tsybikoff made an extremely valuable collection of 317 volumes (now in the hands of the St. Petersburg Academy of Sciences) of Tibetan books on philosophy, medicine, astronomy, history and geography, as also of prayers and incantations, written by the most renowned lamas for the last nine centuries.

The paper is illustrated by nine excellent photographs, representing views of Lhassa, the palace of the Dalai-lama, and the monasteries of Galdan and Dashi-lhunbo. The pictures are taken from the collection of M. Norzunoff, a Kalmyk pilgrim who also was at Lhassa in the same year, and brought back forty-five photographs. M. Tsybikoff's collection (twenty-one photos) reached the Russian Geographical Society after the views mentioned above had been printed.

Those who are interested in Tibet will be glad to know that, besides the diary of the Buryate Zayaeff, who visited Central Tibet in the eighteenth century, the diary of the Kalmyk Baza-bakshi Menkejieff was published in 1897, with a Russian translation by Prof. Pozdnéeff.

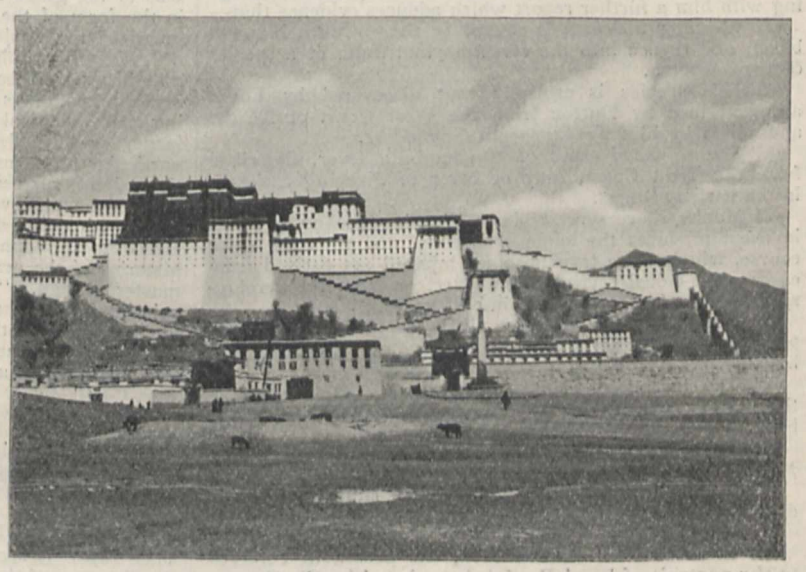


FIG. 1.—Bodala, the palace of the Dalai-lama at Lhassa, seen from the south. (It is built on the cliff Mar-bo-ri, which rises above the plain of the Ui-chu River, about two-thirds of a mile from the city itself).

ANNIVERSARY MEETING OF THE ROYAL SOCIETY.

AT the anniversary meeting of the Royal Society on Monday, the officers and council for the year were elected, the report of the council was read, and the president delivered his address. In the following list of the elected council, the names of new members are printed in italics :—

President, Sir William Huggins, K.C.B.; Treasurer, Mr. A. B. Kempe; Secretaries: Prof. Joseph Larmor and *Sir Archibald Geikie*; Foreign Secretary, Mr. Francis Darwin. Other Members of the Council: *Mr. G. A. Boulenger, Prof. J. R. Bradford,* Prof. H. L. Callendar, *Mr. F. W. Dyson,* Prof. H. B. Dixon, Sir Michael Foster, K.C.B., *Prof. P. F. Frankland, Sir Robert Giffen, K.C.B., Prof. W. D. Halliburton, Dr. E. W. Hobson,* Prof. J. W.

Judd, C.B., Prof. G. D. Liveing, Prof. A. E. H. Love, *Mr. Adam Sedgwick, Dr. W. N. Shaw,* Capt. T. H. Tizard, R.N., C.B.

The report of the council refers, among other matters, to the work of the National Physical Laboratory and the scientific results obtained, the International Association of Academies, the International Catalogue of Scientific Literature, International Aëronautics, and sleeping sickness.

In February last, Lieut.-Colonel Bruce, F.R.S., went to Uganda to study sleeping sickness, with Dr. Nabarro as bacteriologist. Soon after their arrival, Dr. Castellani, who was then in Uganda, reported to Colonel Bruce that during the past five months he had observed trypanosomes in the cerebro-spinal fluid of cases of sleeping sickness, and a telegram was received from Colonel Bruce in April stating that he considered it very probable that a trypanosome was the cause of the disease.

Since then a report entitled "Progress Report on Sleeping Sickness in Uganda" has been received and published as No. 2 Report of the Sleeping Sickness Committee.

Colonel Bruce returned to England in September, bringing with him a further report which adduces evidence that—

(1) Sleeping Sickness is caused by the entrance into the blood, and thence into the cerebro-spinal fluid, of a species of trypanosoma.

(2) This species is probably that discovered by Forde and described by Dutton from the West Coast of Africa, and called by him *Trypanosoma Gambiense.*

(3) The so-called cases of trypanosoma fever, described from the West Coast, may be cases of Sleeping Sickness in the earliest stages.

(4) Monkeys are susceptible to Sleeping Sickness, which in them produces the same symptoms, and runs the same course, whether the trypanosomes injected are derived from cases of so-called trypanosoma fever, or from the cerebro-spinal fluid of cases of Sleeping Sickness.

(5) Dogs and rats are partially susceptible, but guinea-pigs, donkeys, oxen, goats, and sheep, up to the present, have shown themselves absolutely refractory.

(6) The trypanosomes are transmitted from the sick to the healthy by a species of tsetse fly, *Glossina palpalis,* and by it alone.

(7) The distribution of Sleeping Sickness and *Glossina palpalis* correspond.

(8) Sleeping Sickness is, in short, a human tsetse fly disease.

In the course of his address, the president referred to the portrait of Lord Rayleigh, painted by Sir George Reid, which was formally presented to the society at Monday's meeting, and to the retirement of Sir Michael Foster, the senior secretary. A large part of the address was devoted to suggestions which have been made to affiliate important special or local societies with the Royal Society. A committee appointed to consider the question some time ago decided that the Royal Society, both as to its administration and work, should remain as heretofore, and not enter into any formal relationship with special societies. Support was, however, given in the address to the need of integration in respect of publications of the Royal and other scientific societies. The joint publication of papers was brought before the council several years ago, but was not received with favour. It has since been found to work successfully with the Royal Astronomical Society, and the opinion is expressed that other societies might arrange for the duplicate publication, in their own *Transactions,* of papers communicated to the Royal Society of special interest to the respective special societies. This plan leaves each society to its complete independence, and does not involve the Royal Society in any obligation which would in any way interfere with its own free administrative working.

The work of this year's medallists was described in the address as follows:—

Copley Medal.

The Copley Medal is awarded to Prof. Edward Suess, For. Mem. R.S., in recognition of his eminent services to Geology, and especially of his original researches and conclusions published in his great work, "Das Antlitz der Erde."

Prof. Suess was for 40 years Professor of Geology in Vienna University, and under his guidance a school of Geology has arisen, which is not surpassed in any country of the world. He has written numerous papers on Stratigraphical and Physical Geology, and has published much valuable palæontological work. The results of many years of study were contained in "Die Entstehung der Alpen," published in 1875. In this book he traced the geological history of the Central European ranges, and applied the results of his inquiry to the problems of mountain formation and surface contours in general. This work was followed, in 1885, by the first volume of "Das Antlitz der Erde," in which the same problems were attacked on a wider field. The second volume was published in 1888, but the first part of the third volume was not issued until 1901. In this great work the study of the changes that have taken place during geological times in the oceans and seas of the globe is combined with inquiry into alterations in the form of the solid surface. Owing to the wonderful grasp of the subject, and the striking originality shown, the work has influenced geological thought to an extent that has seldom been equalled.

Many geologists have distinguished themselves by mastering the geological structure of different countries, small or large, or have devoted their energies to the solution of particular problems; Suess has aimed at giving an explanation of the surface features exhibited by the whole world, founded on an investigation of its geological history. The forms of continents and islands, the distribution and direction of mountain ranges, the profiles, contours, and histories of the great oceans—all are treated by him with a master's hand. "Das Antlitz der Erde" represents the culmination of the Geology of the nineteenth century; as has been most aptly said by Marcel Bertrand in his preface to the French translation, it is the last term of the revolution commenced a century ago by Werner and Hutton.

Royal Medal.

A Royal Medal is awarded to Sir David Gill, K.C.B., F.R.S., for his researches in Solar and Stellar Parallax, and his energetic direction of the Royal Observatory at the Cape of Good Hope.

Sir David Gill (H.M. Astronomer at the Cape Observatory since 1879) is specially distinguished for his researches on the distances of the heavenly bodies, although his other work has covered a large field. He has made four independent determinations of the sun's distance by heliometer observations of Mars (1877), Iris (1888), Victoria (1889), and Sappho (1889), being ably assisted in some of these investigations by others, but undertaking the greater part of the work himself. The four determinations agree wonderfully well in giving a solar parallax very near 8″·80, which has consequently been adopted for general use in national Ephemerides since the beginning of the present century. Incidentally this work gave improved values for other constants of the solar system, especially the lunar equation in the sun's motion; and it suggested that the time had arrived for an entirely new method of observing the places of the planets, which Sir David Gill has since initiated.

He has also determined the parallaxes of eleven stars of the first magnitude, and four stars of larger proper motion; and several similar determinations carried out by others have been inspired by Sir David Gill. And he has discussed the results from a cosmical point of view. In such work he takes a first place among astronomers.

In addition to these researches of the normal type, Sir David Gill, by his energy and enterprise, has placed the Cape Observatory in the front rank; so that for the first time in the annals of Astronomy we have now at length an observatory of the highest class in the Southern Hemisphere. He has brought up to date the current reductions, and has produced several valuable catalogues of stars, in which particular attention has been paid to the elimination of small errors, notably the "magnitude-equation," to

which Sir David Gill was himself the first to direct attention. And he has completely photographed, on a moderate scale, the Southern Hemisphere. The plates were measured in Holland by Kapteyn, who has published the results recently in a valuable work, the "Cape Photographic Durchmusterung," for which Kapteyn received the Royal Astronomical Society's Gold Medal in February, 1902. It may be recalled that on that occasion Kapteyn expressed very warmly his indebtedness to Sir David Gill.

Sir David Gill had a large share in initiating the International Astrographic Chart; he has also been very active in superintending the Geodetic Survey in South Africa.

ROYAL MEDAL.

The other Royal Medal is conferred upon Dr. Horace T. Brown, F.R.S., for his work on the chemistry of carbohydrates, and on the assimilation of carbonic acid by green plants.

His memoir (H. T. Brown and G. H. Morris, *Journ.* Chem. Soc., 1893) on the "Chemistry and Physiology of Foliage Leaves" is of value as confirming the rougher work of Sachs on the amount of carbohydrate assimilated per leaf area per unit of time, but especially as being the first thorough investigation into the manufacture and translocation of the various sugars in the green leaf. This paper also contributes to our knowledge of the action of diastase in the leaf; and in this connection may be mentioned the paper on the "Germination of the Gramineæ" (H. T. Brown and G. H. Morris, *Journ.* Chem. Soc., 1890), which is a valuable contribution to the study of diastase and other enzymes.

His Presidential Address to the Chemical Section of the British Association, 1899, gave an account of work of the highest interest to botanists, such as the relation between the amount of assimilation of carbon and the partial pressure of the carbonic acid in the atmosphere, and the rate of absorption of carbonic acid by a leaf, as compared with the absorption by a solution of caustic alkali. These and other points are developed in the memoir on "Static Diffusion of Gases and Liquids in Plants" (H. T. Brown and F. Escombe, *Phil. Trans.*, 1900), which is one of the most important works on assimilation by plants that we possess. In this remarkable essay, Brown develops the principles determining the amount of diffusion from gases and solutions into absorbing surfaces, and shows that leaves conform in the size and number of the stomata to absorbing surfaces of high efficiency.

The earliest important chemical work of Horace Brown was on the influence of pressure on fermentation. He discovered that other gases besides carbonic acid were given off in the fermentation of malt worts and of grape sugar, and that the hydrogen evolved increased as the pressure was diminished. The formation of acetic acid during the fermentation out of contact with air was shown to be due to a direct transformation of the sugar into acetic acid.

In conjunction with Heron and Morris, he made a series of valuable investigations into the nature of starch and its transformations. He showed that the action of malt extract upon soluble starch might be represented by the *successive* removals of maltose by hydration (hydrolysis), the successively formed residues being a series of dextrins.

He was the first to apply Raoult's freezing-point method to the systematic determination of the molecular weights of the carbohydrates, and his measurements showed that soluble starch was much more complicated than the dextrins derived from it, the starch molecule possibly consisting of four complex amylin-groups arranged round a similar fifth group. But later work on dextrinic acid led to the view that the starch molecule is made up of the residues of 80 *maltan* groups and 40 *dextran* groups, linked in ring form through oxygen atoms, and that the maltan portion of the ring is attacked by successive stages of hydrolysis, forming dextrins and finally maltose. The molecular weight of starch cannot be less, according to these experiments, than 32,400.

The investigation of "secondary fermentation" produced by a small quantity of dried hops in beer led to his important work on the chemistry and physiology of foliage leaves, in which he gives reasons for supposing that cane-sugar is the first sugar to be synthesised by the assimilatory processes, and that this is the starting point of the metabolic changes in the leaf.

The discovery of the solution of the cell-membranes of grass seeds by a cellulose-dissolving enzyme secreted in the epithelium led him to investigate the corresponding action on the cell-walls of starch granules in the processes of animal digestion. After exhaustive experiments, he concluded that the cell-walls were attacked by an enzyme pre-existent in the grain.

DAVY MEDAL.

The Davy Medal for the most important discovery in chemistry is awarded to M. Pierre Curie, and Madame Curie, Docteur ès Sciences, for their researches on radium.

The discovery of radium—whether it be regarded from the point of view of the extraordinary properties of that substance, unique in their intensity if not in their kind, or of the undeviating aim and invincible patience with which the clue to its separation has been skilfully followed, or of the extended, even revolutionary, views of the constitution of matter and of the stores and transformations of energy in Nature which the study of its properties is opening up to us—may well be characterised as the most important discovery in chemistry of the present time.

HUGHES MEDAL.

The Hughes Medal is awarded to Prof. Johann Wilhelm Hittorf for his experimental researches on the electric discharge in liquids and gases, extending over a period of more than half a century into the present year.

The results of his work have been published in a series of papers, of which the first, on the electric conductivity of mercury, appeared in *Poggendorff's Annalen* so long ago as 1851, and was followed, in the years 1853 to 1859, by others, giving an account of his masterly investigations of the migrations of the ions in electrolysis. In conjunction with Plücker he took up the examination of the spectra emitted by gases under the influence of electric discharges from an induction coil, and communicated the results to the Royal Society in 1864; and in the ensuing twenty years he published, from time to time, a number of papers on electric conductivity in gases, which have greatly contributed to the advancement of our knowledge of that subject. In 1898 and 1899 he published papers on the electromotive behaviour of chromium and on the passive state of metals, and in the three years of the present century further papers on the rates of motion of the ions.

It is now the jubilee of the publication of his first paper on the last-named subject, a paper which marks an epoch in our knowledge of electrolysis. In that paper, and those which followed it in the next five years, by his careful measurements of the movements of the ions in a great variety of cases, he laid a solid foundation on which subsequent investigators have reared a large superstructure. The view of the constitution of electrolytes, and of chemical compounds in general, to which his research directly led, was so contrary to that in vogue amongst chemists at that time that it challenged opposition, but time has vindicated its accuracy and importance. His researches on electric conductivity in gases have been almost equally fruitful, for they have served as the starting point from which other observers have advanced, and have thus led up to modifications of our ideas of the constitution of matter quite as profound as those suggested by the migrations of the ions.

PROF. ROBERT HENRY THURSTON.

BY the death of Prof. Robert Henry Thurston, which occurred with tragic suddenness on his birthday, October 26, the United States has lost its most distinguished engineering professor, and a devoted educationist whom it will be difficult to replace.

He was born at Providence, Rhode Island, in 1839, and was the son of Robert L. Thurston, the founder of the Providence Steam Co. His early training was of that twofold character which has been so much discussed during the last year or two, a collegiate education at the Brown University, where he gradu-

ated C.E., Ph.B., in 1859, and a practical training during the same time in the workshops of his father's firm.

In 1861 he entered the United States Navy, serving from 1861–1865 first as assistant engineer and then as engineer in charge of vessels; this period covered the great Civil War, and the unique experience which Thurston then enjoyed no doubt did much towards turning his mind to experimental research, and probably altered the whole course of his life's work.

In 1865 he was appointed assistant professor of natural philosophy in the United States Naval Academy at Annapolis, and as his chief died a few weeks afterwards, Thurston had entire charge of the department until he resigned the post, in 1871, in order to take up the duties of professor of mechanical engineering in the Stevens Institute of Technology, an office he held until 1885.

It was while he held this chair that Thurston began to make his name known, not only in America, but in Europe; he was a prolific writer on technical subjects, and did much valuable research work in connection with the U.S. Board appointed to deal with the subject of testing metals, notably in the investigation of the properties of the various alloys of copper, tin, and zinc. During this period he also visited Europe as the U.S. Commissioner to the Vienna Exposition of 1873, and on his return published a valuable report.

In 1885 he took up the post which he held until his death, that of director of Sibley College; here he had full scope for his remarkable powers as a teacher and an organiser of scientific education of the most advanced character, and the most eloquent testimony to his success is the extraordinarily rapid growth in the number of students; from a mere handful in 1885, in eighteen years they have increased to nearly 1000, and Sibley College to-day stands in the very front rank of the great technical colleges of the world devoted to the scientific training of the men who are to be the leaders of the engineering profession in all its branches. Much of its success is due to the fact that he was from the first able to win the sympathy and support of the leading engineers of the States, with the result that the Sibley College graduates never find the least difficulty in securing paid posts as soon as they finish their college training.

Thurston altogether wrote some 20 volumes and more than 300 separate scientific papers; his fertility with the pen, when one considers the labours he daily went through as a teacher and director, is amazing, and some of his books bear traces of the haste and pressure under which they were produced.

Of his books, the most noteworthy are the following:—"Friction and Lost Work," "The Materials of Engineering," "A Manual of the Steam Engine," "Steam Boiler Construction," and "A History of the Steam Engine"; these are all in America recognised as standard works, and have found a ready sale also in this country. In fact, Thurston almost attained the same position as was held by Rankine for so many years in this country, and his books were consulted and used by thousands of young engineers scattered throughout the length and breadth of the great Republic.

Thurston was naturally the recipient of many honours; he was the first president of the American Society of Mechanical Engineers, holding office from 1880 to 1883, vice-president of the American Association for the Advancement of Science in 1877, 1878, and 1884, an LL.D. of the Brown University in 1889, &c.; he was twice married, in 1865 to Susan Taylor Gladding (she died in 1878) and in 1880 to Leonora Boughton.

Though Thurston devised several special forms of testing machines, he was not an inventive genius, and he did no work as a constructive engineer. It was as a writer and speaker that he made his influence felt, and how great that influence was will only be fully realised now that he has gone. T. H. B.

SIR FREDERICK BRAMWELL, F.R.S.

THE death of Sir Frederick Bramwell on Monday deprives engineering of one of its most energetic workers, and pure science of one who did much to promote its interests.

Sir Frederick Bramwell was born in London on March 7, 1818, and was apprenticed to one of the old school of mechanical engineers when he was sixteen years of age. After a varied experience he commenced practice on his own account as a civil engineer in 1853, and the following year became a member of the Institution of Mechanical Engineers. He was elected an associate of the Institution of Civil Engineers in 1856; and in 1862 attained full membership.

In 1874 Bramwell was chosen president of the Institution of Mechanical Engineers, and delivered an address in which he appealed to engineers to use to their utmost, and to use fairly, the natural resources at their command. As president of the Institution of Civil Engineers in 1884, he described in his address the chief factors of past progress, and advocated the treatment of large steel forgings by hydraulic pressure in place of steam hammers. He was president of the Mechanical Science Section of the British Association in 1872, and again at Montreal in 1884. He was elected president of the Association for the Bath meeting in 1888, when he delivered an address on the greatness of the works which the engineer creates out of minute beginnings.

Sir Frederick Bramwell received many marks of recognition from public bodies and learned societies. In 1873 he was elected a Fellow of the Royal Society. In 1881, the *Times* relates, he was appointed member of the Ordnance Committee, and in that capacity assisted in the framing of the rules under which iron and steel for the construction of large ordnance are tested before acceptance. After serving on the council and as a member of the board of management he was, on the retirement of Sir William Bowman in 1885, made honorary secretary of the Royal Institution. Always cordially lamenting the lack of facilities for technical education in his youth, he was a warm supporter of the movement for its advancement in this country. On the foundation of the City and Guilds of London Institute he was appointed by the Goldsmiths' Company one of its representatives on the governing body. A knighthood was conferred upon him in 1881, and a baronetcy in 1889. He received the honorary degree of D.C.L. from the Universities of Oxford and Durham, and that of LL.D. from Cambridge and McGill.

NOTES.

PROF. LUDWIG BOLTZMANN has been elected honorary member of the Moscow Academy of Sciences.

THE deaths are announced of Prof. Heinrich Moehl, director of the meteorological station at Cassel, at the age of seventy-one, and Dr. Nagel, formerly professor of geodesy in the technical high school at Dresden.

THE next meeting of the American Association for the Advancement of Science, and affiliated societies, will be held at St. Louis during convocation week beginning on

December 28, under the presidency of the Hon. Carroll D. Wright, U.S. Commissioner of Labour and president of Clark College.

THE Decimal Association has taken steps to introduce into the House of Lords early next session a Bill for the compulsory adoption of the metric weights and measures throughout the United Kingdom. The first reading of the Bill will be moved by Lord Belhaven and seconded by Lord Kelvin. If the measure passes the House of Lords, it will be brought before the Commons at the first possible moment, and it is hoped that a sufficient expression of public opinion will be forthcoming, at the time when the question is being debated, to convince the Government that they will do well to make it their own Bill.

WE have received a circular, the fifth, from the permanent committee of the International Congress of Botany, the second session of which is to be held at Vienna in 1905. At the Paris Congress, in 1900, the board of management on that occasion was constituted a permanent committee so that the congress might be in a position to communicate with the promoters of the Vienna meeting with a view to ensure complete success. The circular gives full information of the steps taken by the permanent Paris committee in the matter of botanical nomenclature, and describes the principles by which their discussions on this subject have been governed. All communications referring to the congress should be addressed to the general secretary, Dr. A. Zahlbruckner, Vienna, I., Burgring 7.

THURSDAY next, December 10, will be the 300th anniversary of the death of William Gilbert. In commemoration of this tercentenary the Mayor and other representatives of the Borough of Colchester will attend the meeting of the Institution of Electrical Engineers on Thursday next to receive a historical picture representing Dr. Gilbert in the act of showing his electrical experiments to Queen Elizabeth and her Court, which will then be presented by the Institution to the Borough of Colchester, where Gilbert was born in 1544, and died in 1603. At the conclusion of the presentation an ordinary general meeting will be held, at which a paper on the slow registration of rapid phenomena by strobographic methods: the "ondographe" and "puissancegraphe" (wave recorder and power recorder), will be read by M. E. Hospitalier, president of the Société Internationale des Électriciens. If time permit, a paper will also be read on the magnetic dispersion in induction motors, and its influence on the design of these machines, by Dr. Hans Behn-Eschenburg.

IN the *Journal de Physique* M. C. Maltézos discusses the sand ripples produced both by wind and water in connection with the theory that they represent the position of nodal lines produced by the interference of direct and reflected waves. This theory is supported by the author's observations made at Phalara (Attica), and a similar explanation is given of the agglomerations of pebbles which occur on many beaches. The phenomena are easily observed by anyone residing near the sea-shore, and an interesting feature is that ripples are formed in the sand even at depths of two or three metres.

PROF. A. RIGHI, in a paper read before the R. Accademia delle Scienze dell' Istituto di Bologna on May 24, describes experiments upon the electric charge generated by X-rays upon metals *in vacuo*. He begins by describing experiments confirming those of Curie and Sagnac, who proved that metals under the action of X-rays give off negative electrons or kathode rays, acquiring in consequence a positive charge which may become considerable if the pressure, and in consequence the ionisation, of the surrounding air be low enough. He next describes comparative measurements of the potential thus acquired under identical conditions by various substances. The last section treats of the variation of the potential acquired by the metal exposed to the X-rays, as its distance from the electrode facing it is varied.

IN the *Scientific Transactions* of the Royal Dublin Society, Mr. Arthur W. Conway, in a short note of four pages, discusses the fundamental equations of electrodynamics, and points out the difficulties attaching to existing theories when radiation is taken into account. The author proposes a system, consisting of a modification of Helmholtz's theory, which he considers is free from the objections attaching to Levi Civita's system. The equations assumed agree with the known relations for electrostatic phenomena, whilst for slow motions they reduce to those given by Helmholtz, which account for the phenomena of electric currents.

MR. J. MORROW publishes in the *Philosophical Magazine* some experiments on the determination of Poisson's ratio by means of a new instrument for measuring the lateral contractions of tie-bars. The instrument has two screws which touch the bar at the points between which the contraction is to be measured, and when the specimen is extended longitudinally the relative displacement of these screw-ends is determined optically. With this instrument values of Poisson's ratio were found for steel, cast iron, wrought iron, brass and copper, agreeing very well with Stromeyer's results.

DURING his exploration of Lake Aral in the years 1900 and 1901, M. L. N. Berg made the very interesting observation that this lake, which had been rapidly decreasing during the years 1850 to 1885, began slightly to increase in 1891. The level was raised during the years 1891 to 1901 by an average of 20 cm. every year. It appears now that during his exploration of Lake Balkhash, which he visited last summer, M. Berg found that this lake also, which was formerly drying up very rapidly, has begun lately to increase. On all sides poplar trees and bushes submerged to some extent are to be seen, while several peninsulæ, like Bai-kabyl, have become islands, and the road from Vyernyi to Karakol is now under water. The waters of the lake are extremely poor in animal life. The explorers found only two species of fishes—one of them the *Perca schrenckii*, special to this lake—while "the bottom of the lake is a real desert—no molluscs, not one worm." The plankton of the lake is, on the contrary, very rich in fresh-water forms. M. Berg found, moreover, to his great astonishment that the water of the lake in June last was quite fresh, along both the southern and the northern shores. As the Balkhash has no outflow, this fact is of special interest.

DR. A. E. WRIGHT AND CAPTAIN S. R. DOUGLAS show by a series of ingenious experiments that the fluids of the blood play an important *rôle* in connection with phagocytosis, the absorption and destruction of bacteria by certain of the white cells of the blood. By mixing bacteria with the white cells of the blood obtained by centrifuging and adding blood serum (*a*) unheated, *i.e.* in the natural condition, (*b*) heated to 60°–65° C. for ten to fifteen minutes, it is found that, under the same conditions, phagocytosis is much more active in the presence of the unheated than of the heated serum. The heating appears to destroy some

activating substance in the serum, the heated serum behaving as a simple diluent, like physiological salt solution (*Proc.* Roy. Soc. Lond., vol. lxxii. p. 357).

THE October number of the *Emu* contains the photograph of a subadult Australian barn-owl in which large bunches of the nestling down are retained on the legs, thus communicating to the bird a most remarkable appearance.

THE osteology and affinities of the kingfishers form the subject of an article in the October number of the *American Naturalist* by Dr. Shufeldt, who arrives at the conclusion that these birds are probably nearly related to the cuckoos, bee-eaters, and jacamars, although further investigations into the morphology and life-history of all these groups are necessary before these complicated relationships can be properly defined.

AN interesting addition to the British marine fauna is recorded in the November issue of the *Zoologist*. Until 1899, when it was discovered on the coast of Brittany, the giant goby (*Gobius capito*), a fish attaining a length of 9 or 10 inches, was believed to be confined to the Mediterranean. As the result of a careful search of the rock-pools last summer, Mr. F. Pickard-Cambridge has demonstrated its comparative abundance on the Cornish coast. In the same journal Mr. P. Podmore describes and figures some fertile hybrids bred from the ring-dove (*Columba palumbus*).

THE study of animals from the point of view of adaptation to their surroundings is now the fashion. The October number of the *American Naturalist* contains the first of a series of three or four articles written at the suggestion of Prof. H. F. Osborn on the adaptation of mammals to aquatic, arboreal, fossorial, and cursorial habits. Prof. Osborn states that a number of advanced students have undertaken the necessary investigations, and that the results are of great interest, and in some instances novel. The first of the series, by Mr. R. C. Osburn, deals with adaptations to an aquatic existence. It is pointed out that the extent to which this adaptation has been carried indicates the relative date at which an aquatic or semi-aquatic life was commenced. Most aquatic mammals have depressed and expanded tails, but in the musk-rat and Potamogale this organ is compressed. The latter animal, at any rate, swims, like a newt, by the aid of its tail, to which the hind-limbs are closely pressed; consequently there is no need for webbed feet. Kükenthal's theory that the increased number of phalanges in the flippers of cetaceans is due to the development of double epiphyses, one of which forms an additional phalange, is considered to be probably true. The fact that toothed cetaceans display indications of descent from an armoured ancestor, while the whalebone whales probably trace their descent from a fully haired form, seems to support the diphyletic origin of the two groups.

PAMPHLET series No. 25, issued by the Imperial Department of Agriculture for the West Indies, contains a paper on ground nuts in the West Indies, by Mr. W. G. Freeman, until recently the scientific assistant to the Department. Hitherto, although ground nuts are easily grown in the islands, no attempt has been made to cultivate them on a sufficiently extensive scale to supply even local requirements, and quantities have consequently had to be imported. A summary of the results of the experiments on the cultivation of seedling and other canes at the experimental stations at Barbados, 1903, is given in No. 26 of the same series of publications. There were twenty-two fields of canes under experimental cultivation on nine estates situated in typical localities, the canes in each case being treated in exactly the same manner as the other canes on the estate. The best all-round cane proved to be the Barbados seedling, B 208, the second place being taken by B 147, the average quality of its juice being fair.

THE reintroduction of cotton growing into the West Indian Islands has soon been followed by the appearance of a destructive pest, the cotton worm or caterpillar—*Aletia argillacea*—which is causing considerable anxiety, as it strips a whole field in a single night. It is affecting Barbados, Montserrat, Antigua, and St. Kitt's-Nevis. The officials of the Agricultural Department are actively engaged in devising methods for efficiently coping with the evil.

DR. A. FREIHERR VON BISTRAM has reprinted from the *Berichte* der naturforschenden Gesellschaft zu Freiburg im Breisgau his paper on the dolomite region of Lugano. It is accompanied by an excellent coloured geological map on the scale of 1 : 50,000, and the author has occasion to praise the contoured maps of the Italian Government, which, on this large scale, and with well-marked footpaths, have proved of service to so many geologists. The most striking feature of the district is the great east-and-west fault dividing the Triassic beds from the crystalline rocks on the north. The dolomite is thickened locally by repetition through earth-movements, after the fashion made familiar to us by the work of Dr. Ogilvie-Gordon and others, but the similarity of the strata prevents adequate mapping of the details. The style of the author enables one clearly to realise the landscapes, as in his picturesque description of the Val Solda. The obliquity of the axis of the Lake of Lugano to the structural folding of the district leads him to assign to it a glacial origin. The author lays stress on the primary differences in the strata deposited in neighbouring areas, as affecting the manner of their subsequent deformation. His notes on the sections actually visible make the paper especially useful to subsequent visitors, and some of his criticisms affect the published maps of the Swiss Geological Survey.

THE *Scientific American*, in its issue for November 14, publishes a very complete and excellently illustrated account of modern printing methods, machines and appliances.

MESSRS. MACMILLAN AND CO., LTD., have issued part iv. of "A School Geometry," by Messrs. Hall and Stevens. The booklet runs to twenty-eight pages, and contains the substance of Euclid Book ii., together with Book iii., Props. 35–37. Its price is 6*d*.

MESSRS. LONGMANS, GREEN AND CO. have just published a small work on "The Analytical Chemistry of Uranium," by Mr. H. Brearley, which contains a mass of information relative to the determination of the metal in its ores and in commercial products. The material is divided into four chapters, dealing respectively with the modes of estimating uranium, the estimation of uranium as phosphate, the separation of uranium, and the analysis of uranium ores.

MESSRS. CHARLES GRIFFIN AND CO., LTD., have published the twentieth annual issue of the "Year-book of the Scientific and Learned Societies of Great Britain and Ireland." The publication forms a record of the work done in science, literature and art during the session 1902–1903 by a large number of societies and Government institutions. The information has been compiled from official sources, and should consequently be quite trustworthy. We notice that no details of the Geographical Association are given, or of the Association of Science Masters in Public Schools.

THE determination of vapour densities at high temperatures by application of the diffusion method of Bunsen is discussed in a paper by Prof. Emich communicated to the Vienna Academy. For one and the same gas at different temperatures the time of diffusion of a given volume should be proportional to the square root of the absolute temperature. Experiments with tubes of porcelain, platinum, and iridium show that this requirement is approximately fulfilled, and investigations on diffusion are now being carried out up to a temperature of 2000° C.

ACCORDING to Mr. W. Ackroyd, colour changes are frequently brought about by the action of radium rays. These changes have been examined by embedding a radium bromide tube in the substance experimented upon. After a few hours sodium chloride becomes orange or buff coloured, potassium chloride becomes violet but returns to its original colour very quickly after removal of the exciting cause. Sodium bicarbonate and potassium metabisulphite are changed to amethyst colour after twenty-four hours' exposure.

WE have received the second number of vol. i. of the *Journal de Chimie physique*, published under the direction of Prof. Guye, of Geneva. The number contains two interesting papers, one by Prof. Duhem on the eutectic and transition points of binary mixtures which give rise to mixed crystals, the other by Prof. Guye on the electrolysis of alkaline chlorides. The reviews of current physicochemical literature which form the second part of the publication are exceedingly well written, and the papers reviewed are, moreover, of quite recent publication, a statement which cannot be made of many abstracts in other physicochemical journals.

IN the November issue of the *Moniteur Scientifique* M. Combes discusses the various attempts which have been made to obtain the diamond artificially. Against the common supposition that the diamond can only be produced at high temperatures, the author cites several observations which seem to indicate that natural diamonds, at any rate, cannot have been formed under such conditions. The hypothesis that high pressures are necessary for the artificial production of diamonds is not in accord with actual experimental facts, and the author arrives at the conclusion that in the experiments of Moissan the pressure plays no essential part, and that the optical properties and the analysis of the crystals obtained by this chemist do not warrant the conclusion that these are to be regarded as diamonds.

THE additions to the Zoological Society's Gardens during the past week include a Bonelli's Eagle (*Nisaëtus fasciatus*), European, presented by Mr. G. H. Baxter; a Matamata Terrapin (*Chelys fimbriata*) from Guiana, presented by Mr. E. Bieber; a Yellow-fronted Amazon (*Chrysotis ochrocephala*) from Guiana, a Lesser Sulphur-crested Cockatoo (*Cacatua sulphurea*) from Moluccas, a Common Buzzard (*Buteo vulgaris*), European, deposited; an Ourang-outang (*Simia satyrus*) from Borneo, purchased.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN DECEMBER :—

Dec. 3. 6h. 44m. Minimum of Algol (β Persei).
6. 17h. 40m. to 18h. 41m. Moon occults λ Geminorum (Mag. 3·6).
11. Predicted perihelion passage of Brooks's periodical comet (1889 V–1896 VI).
11–13. Epoch of Geminid Meteors (Radiant 108°+33°).
14. 12h. Venus in conjunction with the Moon. Venus 0° 5′ S.
Dec. 15. Venus. Illuminated portion of disc =0·586.
16. 3h. 7m. to 6h. 26m. Transit of Jupiter's Sat. III.
20. 12h. Mars and Saturn in conjunction (Mars 0° 33′ S.).
22. 12h. Sun enters Capricornus. Winter commences
23. 7h. 17m. to 10h. 36m Transit of Jupiter's Sat. III.
,, 8h. 27m. Minimum of Algol (β Persei).
25. 6h. 0m. Jupiter in conjunction with the moon (Jupiter 2° 40′ S.).
26. 5h. 16m. Minimum of Algol (β Persei).
,, 23h. 0m. Neptune in opposition to the sun.
31. 12h. 50m. Near approach of moon to Aldebaran (α Tauri).
,, 18h. 0m. Mercury at greatest elongation (19° 30′ E.)

DETERMINATION OF STANDARD STELLAR VELOCITIES.—In accordance with the cooperative scheme for regularly determining the velocities of certain standard stars, Profs. Frost and Adams have, during the past twelve months, made independent observations of the radial velocities of thirteen stars, the results of which are given herewith :—

Star	Mean velocity in kilometres per sec.
α Arietis	−13·7
α Persei	− 2·1
β Leporis	−12·4
β Geminorum	+ 3·4
α Crateris	+47·4
α Böotis	− 4·8
θ Ophiuchi	−11·1
γ Aquilæ	− 1·8
γ Cephei	−41·2
ε Pegasi	+ 6·2
γ Piscium	−10·9
ι Aurigæ	+19·0
ε Leonis	+ 5·5

The Bruce spectrograph of the Yerkes Observatory, with various cameras attached, has been used, and, in the majority of cases, the spark spectrum of titanium has been employed to give the standard comparison wave-lengths. Three photographs of each star have been obtained, except in the case of β Leporis, where the low altitude and poor observing conditions have prevented more than one being taken. A range of 1·8 km. in the determined velocities of ε Leonis indicates the existence of a real variation, but more photographs must be measured before the point can be decided. An unaccountable difference of −0·5 km. is shown between the velocity of Arcturus as determined from eight earlier plates and that obtained from the five plates recently obtained, unaccountable because in the spectrum of this star the lines are so well defined (*Astrophysical Journal*, vol. xviii., No. 4).

NEW ELEMENTS FOR η AQUILÆ.—From 352 observations of the magnitude of η Aquilæ, made at the Lyons Observatory between June 3, 1898, and December 22, 1902, M. M. Luizet obtained the times of fifty-five maxima and fifty-three minima, and, on comparing them with those calculated from the elements obtained by Schür, and published in "Chandler's Third Catalogue," he found that a difference amounting, in the mean, to +0·2 day existed, and therefore thought it advisable to compute a new set of elements. This he did by employing the maxima and minima data used by Schür, and combining with them the results obtained from his own observations; the result showed that it was necessary to apply a correction of 0·106±0·021 day to the original epoch of maxima, and 0·0166±0·035 day to that of minima, and, in each case, a slight correction to the length of the period.

Applying these corrections to the data used by Schür, one obtains for the original epochs

Maxima 2396168·738 days,
Minima 2396166·365 days,

and for the length of the period

7·176382 days.

The new elements, based on these data, are as follows :—

Maximum = J.D. 2396 168·738 } (M.T. Paris) + 7·176382 E.
Minimum = J.D. 166·365 } + 0·14 sin (0°·044 E. + 304°)

or

	d.	h.	m.	s.	d.	h.	m.	s.
Maximum 1848 May	20	17	42	43 }	+ 7	4	13	59·4 E.
Minimum ,, ,,	18	8	45	36 }	+ 202m. sin (0°·044 E. + 304°)			

and a comparison of the weighted means of his own and other observations leads M. Luizet to the conclusion that the interval between the principal and secondary maxima is 2·373 days, or 2d. 8h. 58m. (*Astronomische Nachrichten*, No. 3911).

ABSORPTION OF STAR LIGHT BY COMET 1903 *c*.—Prof. Max Wolf publishes, in No. 3914 of the *Astronomische Nachrichten*, two photographs of comet 1903 *c* taken on July 25 when the comet was passing in front of the 6·5 magnitude star B.D.+63°.1056. On comparing these photographs with the observations of comet 1902 III., Prof. Wolf arrives at the conclusion that the later comet exhibited a selective absorption of star light which was not exhibited by the earlier one.

PUBLICATIONS OF THE PULKOWA OBSERVATORY.—Vol. x. (2nd series) of the *Publications* de l'Observatoire Central Nicolas, edited by M. M. Nyrén, contains the details of the observations made with the prime-vertical transit instrument from 1869 to 1896. In the introduction, M. Nyrén discusses very minutely the errors of the instrument and their corrections, paying particular attention to the causes which might produce a small yet persistent residual as yet unaccounted for.

The results were analysed in order to test the validity of Chandler's "$\Delta\phi$" term for the variation of latitude, and they indicate that that observer's empirical formula requires some slight modification, although M. Nyrén hesitates to make a definite statement on this point. The constant of aberration as deduced from these observations is 20″·4423 if Chandler's term be considered; without the latter the value is 20″·4451, and M. Nyrén observes that, in the mean, this term seems of small importance.

In vol. xiii. of the same *Publications* M. Nyrén publishes a new catalogue of 1336 reference stars situated between dec. −30° and dec. +90°. This differs from Struve's Pulkowa catalogue in only containing stars between magnitudes 5 and 7; at least this was the original proposal, but it has been found necessary in practice to admit others which are just outside these limits. The idea of this selection was to include stars which were faint enough to give exact readings, and not too faint to be observed with the vertical circle used. Another feature of the catalogue is the division of the zone into squares, of which each side is 5° in length, and the observation of only one star in each zone, thus ensuring the even distribution of the reference positions without incurring too great a labour in the observations. The section of the zone −15° to +90° was observed at Pulkowa, and stars selected from the Bonn Durchmusterung were used, whilst the remaining section was observed at the subsidiary observatory at Odessa, where the Cordoba catalogue was used. Details of each observation made are given in the catalogue, and, together with the results, they occupy 487 quarto pages.

GUIDE FOR ASTRONOMICAL AND GEODETICAL CALCULATIONS.—Part ii. of Signor J. Boccardi's "Guide du Calculateur" will be found to be an extremely useful reference book by all who desire to perform calculations of observational results in astronomy or geodesy. It gives lucid explanations of many typical computations, such as the calculation of precessional effects, reductions to apparent place, elements of orbits, the determination of an orbit from three observations, and the special perturbations of an orbit; it also explains and illustrates the method of "least squares." Under the heading of "Geodesy" the solutions of many typical problems are explained and examples worked out, several special methods being named and clearly elucidated. Numerous worked examples are given throughout the book, each problem and method being clearly illustrated in this manner. The work is published by M. A. Hermann, 6 Rue de la Sorbonne, Paris.

THE EDISON ACCUMULATOR.[1]

MR. W. HIBBERT read a most interesting paper on the Edison accumulator before the Institution of Electrical Engineers last week. Since the first announcement of Mr. Edison's invention nearly three years ago, very little of an authoritative nature has been published about the cell; the paper which Dr. Kennelly read in May, 1901, showed that the invention was full of promise, and further results of more extensive experiments and of practical trials have since been awaited with eagerness. A description of the cell itself was published in NATURE in July, 1901 (vol. lxiv. p. 241), and as it has undergone little alteration since then we need not describe it in detail here; the active materials, it will be remembered, are nickel oxide and iron, and the electrolyte is a 20 per cent. solution of caustic potash; the chemical changes on charge and discharge may be represented by the equation

$$\underset{\text{After charge}}{NiO_2 \,|\, KHOaq \,|\, Fe} \rightleftarrows \underset{\text{After discharge}}{NiO \,|\, KHO.aq \,|\, FeO,}$$

the electrolyte serving merely as an oxygen carrier, and not taking any actual part in the final changes of the active material, as does the sulphuric acid in the lead-lead-peroxide cell. The active materials are packed in perforated steel pockets, and the plates, though thin, are rigid and light. The construction is thoroughly mechanical throughout, and the lightness is obtained without any sacrifice of durability,

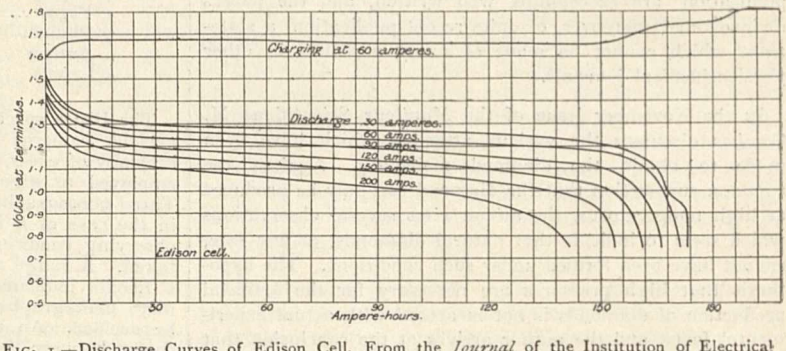


FIG. 1.—Discharge Curves of Edison Cell. From the *Journal* of the Institution of Electrical Engineers.

which is one of the chief faults of the lighter types of lead cells. The standard size of automobile cell is 13 inches high (over all) and 5·1 × 3·5 inches horizontally. The weight is 17·8 lb. The E.M.F. is approximately 1·35 volts, and the internal resistance 0·0013 ohm; the output at 60 amperes discharge is 210 watt-hours, the capacity working out, therefore, at 11·8 watt-hours per lb. This figure agrees very closely with those which were published originally; Dr. Kennelly put the output at about 14 watt-hours per lb., and, in the article referred to above, we calculated from a discharge curve which had been published an output of 10 watt-hours per lb. The lightest lead cells in some instances approach, or even exceed, these figures, but on the average the result is considerably better than that obtainable in practice with lead accumulators. It will be seen, however, that in many other respects the Edison cell promises to prove much superior, especially for motor-car work.

Mr. Hibbert's tests were made partly under laboratory conditions and partly on the road. The discharge curves reproduced in Fig. 1 were taken in the laboratory, and show that the Edison cell possesses in a remarkable degree one very desirable characteristic, namely, that of giving a good output in ampere-hours when discharged at heavy discharge rates. Taking the normal discharge current as 30 or 40

[1] "The Edison Accumulator for Automobiles." By W. Hibbert. Abstract of paper read before the Institution of Electrical Engineers. November 26.

amperes, the curves show that more than 80 per cent. of the normal ampere-hours can be obtained when discharging at so high a current even as 200 amperes. A lead cell under similar conditions would probably not give more than 50 per cent. of its normal output. Experiments on the road showed that this result could be obtained under practical conditions. A 32 mile run was made from Leicester to Northampton against a head wind all the way; on the level the current varied from 55 to 60 amperes, as against the usual 40; uphill it was from 90 to 100 amperes, and on one occasion rose above 150 amperes. The total discharge came out as 190 ampere-hours, the normal standing discharge being 160 ampere-hours. The battery had been fully charged before the start, 242 ampere-hours having been put in in 1 hour and 20 minutes. This particular case shows that there is an extra discharge—30 ampere-hours in this instance—which can be got from the cell; it is due to the fact that the voltage at the end of the discharge does not continue to drop rapidly as shown in the curves in Fig. 1, but, when it has fallen to about half a volt, becomes steady again for another hour. There is, in consequence, a reserve of capacity which, though not generally used, may prove very valuable in emergencies such as the above.

Some other results obtained by Mr. Hibbert may be quoted. A cell after being short circuited for 48 hours recovered its original capacity after two charges, and was apparently none the worse for this severe treatment. Experiments on the rate of charging were tried, and showed that high charging currents can be safely used. A fully discharged cell was recharged for an hour at 177 amperes; 124 ampere-hours, or 70 per cent. of the charge, were obtained on discharge at 60 amperes. Experiments on the road confirmed this result, 70 per cent. of the charge being obtained after charging at 200 amperes. The efficiency of the cell is not quite so good as that of a lead cell; the following figures were obtained under different conditions:—at 30 amperes charge and discharge 66 per cent., at 60 amperes 60 per cent., at 100 amperes charge and 60 amperes discharge 56 per cent., and at 177 amperes charge and 60 amperes discharge about 50 per cent. On the other hand, the cell endures a period of rest before discharge well, and also does not suffer if allowed to stand discharged for some time. If discharged immediately after charge a somewhat large discharge is obtained, but after two days' rest a discharge of 155 ampere hours is given; a further twenty-four days' rest only had the effect of diminishing the discharge to 125 ampere hours, or 80 per cent. of the discharge after the two days' rest.

The trials on the road were made in a runabout with a battery of 38 cells, weighing about 700 lb.; the total weight, with two persons, was about 2000 lb. The trials were planned to afford answers to the following questions:—

(1) Is the capacity the same on the road as in the laboratory?

(2) Will the battery stand excessive discharges on the road?

(3) Will it take a rapid charge and utilise it on the road?

(4) Will it recover after lying discharged for some time?

(5) Does the capacity fall off by reason of the shaking?

(6) What attention is required?

The experiments which we have already quoted show that the answer to the first four questions is in the affirmative. With regard to the fifth question, the results were very satisfactory. The car had run 400 miles before Mr. Hibbert took it over; its capacity was then 159 ampere-hours on standing discharge. Mr. Hibbert ran it in all 500 miles in the course of a month, and at the end of that time the capacity on standing discharge was 158 ampere-hours, showing, therefore, no appreciable deterioration. As regards attention, Mr. Hibbert found very little to be required; none of the terminals worked loose or showed signs of getting unduly warm with the heavy charging currents sometimes used. The only matter that had to be attended to was the replenishing with distilled water which was required after every five or six charges.

The general results of Mr. Hibbert's tests are most encouraging; the only point on which further information is required is durability, but all the evidence is in favour of this proving satisfactory. It certainly seems as if the hopes aroused by Dr. Kennelly's paper are within measurable distance of realisation. M. S.

THE UNITED STATES GEOLOGICAL SURVEY.

WE have received parts i. to iv. of the twenty-second annual report of this survey for 1900–1. In part i., after the administrative report by Mr. C. D. Walcott, the director, there is an elaborate essay on the asphalt and bituminous rock deposits of the United States. The author, Mr. G. H. Eldridge, points out that while sandstones are storage reservoirs for mineral oils or bituminous deposits, limestones may be the place of origin as well as the means of storage. Ozocerite has been formed in some strata by the draining of petroleum pools or of strata richly saturated in oil. The author instances a reservoir in California that rests on granite, and has been filled from overlying deposits.

In part ii. ore deposits are dealt with. There is an account of the tungsten mine at Trumbull, Conn., and it is mentioned that wolframite is produced by alteration of scheelite through replacement of its calcium by iron and manganese. The ore deposits of Rico Mountains comprise galena, often argentiferous, sphalerite or zinc blende, chalcopyrite and magnetite; those of the Elkhorn district include argentiferous galena and gold, and the metalliferous deposits are believed to have been derived from igneous rocks (gabbro) lying beneath limestones, through the agency of uprising hot siliceous waters. The Blue Mountains of eastern Oregon comprise, near Baker City, an important gold-field. The mountains consist of cores of older rocks with Tertiary rhyolites, andesites, and basalts. Gold and silver occur in veins in the older rocks, and gold occurs also in placer deposits. In Monte Cristo, Washington, there are ores of copper, lead, zinc and arsenic. The lead and zinc mines of the Ozark region are dealt with in considerable detail, with respect to the relation and to the concentration of the ores, whether by ascending or descending waters. The original precipitation of the metals is traced back to the agency of organic matter, aided by concentration and evaporation in shallow seas, such as characterised the dolomitic beds of Cambro-Silurian age. Analyses show minute, but important, amounts of zinc and lead in the pre-Cambrian, Cambro-Silurian and Carboniferous rocks. The workable ores have been deposited in the fractured and brecciated areas of Carboniferous Limestone. The author discusses the chemical processes which have led to the deposition of these ores; these have in succession been oxidation of sulphides, transportation as sulphates, and precipitation in the crevices of the rocks as sulphides. Some of the ores have since been superficially changed to carbonates.

Part iii. deals with coal, oil and cement. There are statistics relating to the coal-fields of the United States, particulars about the anthracite coal-field of Pennsylvania, with its disturbed, vertical and overturned coal, and descriptions of various other coal-fields, and of the Gaines oil-field of Pennsylvania. Accounts are given of the Portland cement industry in Michigan, and of the manufacture of hydraulic cement in south-west Arkansas, where chalk comparable with that of England is used.

Part iv. deals with hydrography, with stream measurements, the hydrography of the American isthmus, and of the high plains.

We have received also part i. of the twenty-third annual report for 1901–2. It contains the report of the director, Mr. C. D. Walcott, who describes the methods of work, and appends a memoir, with portrait, of the late Clarence King.

In addition we have received a preliminary report on the Ketchikan mining district of Alaska, by Mr. Alfred H. Brooks, who deals with the gold-bearing properties and with certain silver and lead deposits; and a reconnaissance of the north-western portion of Seward Peninsula, in Alaska, by Mr. A. J. Collier, with reference to the more important gold-fields. These reports, which are naturally somewhat sketchy, will be of service to those who contemplate mining enterprises in the districts.

Two monographs of the Geological Survey have recently been published. Monograph No. xlii. is on "The Carboniferous Ammonoids of America," by Mr. James Perrin Smith. The writer tells us that he makes "no distinction between goniatites and ammonites, because there is none that will hold." He remarks that while nearly all the characteristic

European genera are present in America, some are extremely rare, represented by a single species; others have a different range in America from that in Europe. These differences of range and association give hints as to the region where some of the forms originated, but the information is too indefinite to allow any positive statements as to the faunal geography of that time. The author, however, concludes that at least periodically there was easy intermigration between the American and the European waters, for the community of genera, and even of species, is too great to be explained by any other hypothesis. We note that *Glyphioceras calyx*, *Goniatites crenistria*, *G. sphaericus* and *G. striatus* are recorded from the Lower Carboniferous of America. The work is illustrated by twenty-nine plates.

Monograph No. xliii. is on "The Mesabi Iron-bearing District of Minnesota," by Mr. Charles K. Leith. The iron-bearing formation occurs in the Upper Huronian, and in what is known as the Biwabik division. This comprises a variety of rocks, including slates, cherts, and "greenalite." This last-named substance consists largely of minute granules of green ferrous silicate, without potash, and is named greenalite for convenience. The cherts and iron ores are shown to develop mainly from the alteration of the greenalite granules. Interbedded slate-rocks occur, and paint-rocks have resulted from their alteration. The iron ores are in basin-shaped deposits of considerable horizontal extension. Full particulars are given of these and of the methods of mining, while other rocks which enter into the structure of the district, the Archæan, Lower Huronian, the Keweenawan gabbro, the Cretaceous rocks, and Glacial drifts are described. The work is accompanied by maps, pictorial views, and plates of microscopic sections.

A series of *Bulletins* of the Geological Survey (published 1902–3) has been received. No. 203 comprises the invaluable "Bibliography and Index of North American Geology for 1901," by Mr. F. B. Weeks; 866 works are listed, and they are for the most part accompanied by brief notes of the contents. In No. 191, also the work of Mr. Weeks, there is a list and references to "North American Geologic Formation Names," a work of unquestioned utility. We cannot help thinking that formational terms should, wherever possible, be derived from original place names. Even names like the Appotomax, Bearwallow, Caloosahatchie, Shawangunk or Wapsipinicon beds are preferable to those of Alnwick, Barnstaple, Falmouth, Tisbury and Tiverton beds, some of which have a meaning in this country. Other native names, such as the Anamosa, Keewatin, Shenandoah and Wyoming, and even the Mormon beds, are appropriate.

No. 206 is a study of the fauna of the Hamilton (Devonian) formation of the Cayuga Lake section in Central New York, by Mr. H. F. Cleland. An attempt was made to collect the complete "faunule" from each zone, and it is stated that the examination failed (with one possible exception) to reveal any evolutional changes. The species are as distinct or as variable in one portion of the section as in another. Apparently it makes little difference how much time elapses so long as the conditions of environment remain unchanged. Some repetition of faunas is noted.

In No. 205 Mr. G. B. Shattuck deals with the Mollusca of the Buda (Cretaceous) Limestone, and Mr. T. W. Vaughan deals with the corals. The work is accompanied by many plates of fossils. In No. 204 the fossil flora of the John Day Basin, Oregon, is described and illustrated by Mr. F. H. Knowlton. The beds which yield the plants are Eocene and Miocene.

In No. 195 Mr. T. N. Dale contributes a second paper on structural details in the Green Mountain region and in eastern New York. Various structures in pre-Cambrian and Cambrian rocks, showing the complex interaction of mechanical and chemical processes, are described, and in one case the amount of shear is indicated by deflected annelid borings.

Economic geology receives treatment in several *Bulletins*. No. 199, by Mr. I. C. Russell, is on the geology and water resources of the Snake River plains of Idaho. Many curious volcanic features are illustrated, including some volcanic bombs. No. 198 is on oil sand in Ohio; No. 200, on borax deposits in California, and No. 202 on gold and silver in western Kansas. In No. 207 there is an essay on the action of ammonium chloride upon silicates.

Geography is illustrated in No. 196, wherein Mr. J. S. Diller treats of the topographic development of the Klamath Mountains in California and Oregon; in No. 197, by Mr. H. Gannett, on the origin of some ten thousand place names in the United States; and in No. 201, which contains results of primary triangulation.

The Maryland Geological Survey, under the direction of Prof. W. B. Clark, sends two memoirs on the counties of Cecil and Garrett. These deal exhaustively with the local geology and topography, with the rocks igneous and stratified, the mineral resources, soils, climate, forests, &c. They are well illustrated and admirably printed, and with their colour-printed maps they may be regarded as in all respects models of what geological survey memoirs should be. H. B. W.

WINTER WHITENING OF ANIMALS.[1]

THE winter whitening of animals, though of intense interest to zoologists, is very imperfectly understood. Most writers are satisfied to believe that this colour change was perfected somehow under the action of natural selection for the protective purposes of adaptation to environment. Its origin they leave as an unsolved problem.

I find, however, that the change has a deep physiological significance. There is, for instance, in mammals a definite sequence in which the various parts of the body whiten. This sequence corresponds to the summer accumulation of fat in the panniculus adiposus. Thus the belly, where peripheral fat is thickest, is permanently white, and the rump, where also fat accumulates thickly, is usually the first part to whiten in winter.

Many northern mammals and birds not usually regarded as of the winter-whitening category are lighter in winter than in summer. The whiteness or white patches assumed in the former season correspond to the fat tracts, so that these species may be regarded as subject to the same process.

In the northern summer most animals accumulate fat, always in a definite manner as regards the regions where it is deposited. This fat is indicative of deficient oxydisation and of sluggish metabolism, and the process of its accumulation is therefore one of atrophy. The fat accumulation and atrophy are most marked in autumn, at which season metabolism is therefore lowest. With the onset of winter cold, the atrophy may extend to the hairs. Their pigment (as observed by Metchnikoff) is then removed, always, however, commencing with those parts where peripheral fat is thickest, and atrophy therefore greatest. Should there be a change of coat at this time, the new hairs are influenced by the same conditions. In very cold countries they come up white all over the animal; in more temperate regions the parts only where fat is thickest are white.

Although a pigmented hair can thus undergo atrophy and loss of pigment, I know of no case where the colour is replaced. Animals once whitened remain so until the spring moult.

These facts apply broadly to birds and mammals, but the hare and stoat are the species which I have studied especially.

Similar laws govern a great deal of the distribution of the white colour throughout the vertebrate phylum, wherein the connection between white colour and the peripheral fat tracts (thus indicating local atrophy) may be widely traced. Thus domestic animals, nearly all of which are prized most for their power of accumulating fat, exhibit a strong tendency to the development of white patches. In both these and in wild animals the belly, where occurs the principal fat tract, is the most frequently white part; next follow the rump, and parts of the neck, of the limbs and of the head.

Marked exceptions are, no doubt, frequently due to unusual arrangements of the panniculus adiposus. Thus in the badger, a representative of a family in which the back is usually whiter than the belly, I find a correspondingly exceptional arrangement of the fat tracts.

[1] Abstract of a paper read before the Royal Irish Academy on May 11 by Capt. Barrett Hamilton, on a physiological theory to explain the winter whitening of birds and mammals living in snowy countries, and the most striking points in the distribution of white in vertebrates generally.

The white of the head—the "blaze" of horses, the facial stripes of the badger—often affects regions not of fat accumulation, but where the skin immediately overlies bone and membrane (frontals and nasals and zygomatic arch), which thus seem to produce an atrophy similar to that caused by underlying fat.

In many animals the hair-atrophy assumes the form not of whitening, but of baldness. Marine mammals are hairless in proportion to the development of their peripheral fat-layer; fattening cattle lose their hair, while the baldness of man corresponds in position to the "blaze" of horses, and the bare buttocks of monkeys to the white rumps of other animals.

Yellow and red frequently follow the same rules of distribution as white. They are well known to be fat pigments.

I must carefully guard myself against the extension of my theory to all cases where white occurs in vertebrates. It is obvious that not all animals are subject to this atrophy, and that there must be other causes for absence of pigment. It seems highly probable from what I have written that the known unevenness of animal coloration is but the external indication of uneven nutrition in different regions of the body.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Prof. J. A. Ewing, F.R.S., and Prof. Karl Pearson, F.R.S., have been elected honorary fellows of King's College.

Mr. W. Chawner, Master of Emmanuel, has been appointed an elector to the Sadlerian professorship of mathematics, in succession to the late Dr. N. M. Ferrers.

Mr. C. H. Talbot has presented to the university a number of instruments used for the researches of his father, Mr. H. Fox Talbot, F.R.S.

The Duke of Bedford has presented to the Museum of Zoology a number of valuable specimens of *Cervus davidianas*.

Mr. W. Bateson, F.R.S., and Mr. A. C. Seward, F.R.S., have been appointed members of the botanic garden syndicate; Prof. Marsh a member of the museums syndicate; Mr. W. M. Coates and Mr. E. T. Whittaker members of the observatory syndicate; Dr. D. MacAlister and Prof. Marsh members of the State medicine syndicate; Dr. J. Griffiths a member of the medical board; Mr. F. H. Neville, F.R.S., a member of the board for physics and chemistry; Mr. J. E. Marr, F.R.S., a member of the board for biology and geology; Mr. A. C. Seward, F.R.S., a member of the board for agricultural studies; Mr. F. C. Parsons an examiner in human anatomy.

The grace for the appointment of a syndicate to consider changes in the university studies and examinations was carried by 170 votes *placet* against 79 *non-placet*. The members of the syndicate as proposed were appointed by 156 votes to 92.

IT is reported that the late Mr. Seale Hayne has left residue estate amounting to more than 100,000*l*. for the purpose of establishing a college of science, art, and literature in Devonshire.

UNDER the auspices of several Greek educational societies recognised by the State, an educational congress will be held in April, 1904, in Athens. In connection with the congress it is intended to organise an exhibition of educational books and apparatus which will include an international section. Foreign contributors should deliver their exhibits in Athens not later than February 14, 1904. Detailed information can be obtained from the secretary, M. G. Drossinis, Comité d'Organisation du Congrès hellénique d'Éducation, Bureaux du Syllogue pour la Propagation de Livres utiles, 42 Rue de l'Académie, Athens.

A COMMUNICATION from the Privy Council has been received by the agents for the promotion of the proposed University of Yorkshire with reference to the application for a charter for the Yorkshire College at Leeds. The Lords of the Committee of Council state that, in view of the additional information as to their financial position and prospects which the promoters of the Yorkshire College petition are able to furnish, they agree to recommend the grant of a charter following generally the terms of the draft submitted, on the understanding that the West Riding County Council makes a substantial subvention towards the maintenance of the university, and that the promoters undertake to raise a capital sum of at least 100,000*l*. by the earliest possible date. As to the title of the university, it is pointed out that "The Victoria University of Yorkshire" implies a possessory interest in the whole of Yorkshire, and objection might be made to it. Also, the use of the name "Victoria" might cause confusion with the "Victoria University of Manchester."

THE report on the work of the department of technology of the City and Guilds of London Institute for the session 1902–3 shows a marked increase in the number of examinees from India and the colonies. Last year India sent up 29 candidates and the colonies 148. This year 53 Indian and 238 colonial candidates were presented for examination, 51 from New South Wales and 167 from New Zealand. Applications have been received from Cape Colony for the holding of examinations in telegraphy and telephony, manual training and other subjects, and the Agent-General has undertaken to transmit the question papers to the colonial educational authorities and to afford all necessary facilities for the conduct of the examinations. The number of candidates in cotton spinning examined in India is steadily increasing. In mechanical engineering there is also a large increase. There has been also a continuous and uninterrupted increase in the total number of classes registered by the Institute for instruction and in the number of students in attendance. While in 1902 the number of centres was 364 with 2320 classes and 36,189 students in attendance, in 1903 there were 396 centres, 2789 classes, and 38,638 students.

AT the annual dinner of the Institution of Mining and Metallurgy last week, Sir W. Anson, Parliamentary Secretary to the Board of Education, in proposing the toast of "The Institution," referred to the scheme for a great school of technology in London, and promised the cordial and hearty cooperation of the Board of Education. Some months ago, he continued, the Board had in view the appointment of a committee to inquire into the Royal College of Science and Royal School of Mines in their special relation to this scheme. He thought he could safely say that that committee, of which Sir F. Mowatt had consented to become the chairman, would be appointed, and would commence work in January next. He was glad to be able to assure them of the cordial cooperation of the Board of Education in any scheme for the advancement of practical scientific education. He welcomed the efforts of the Institution of Mining and Metallurgy to advance technological study, because it was of immense importance to the education of the country that they should find among men of business this appreciation of the value of knowledge, of training, and of study.

BY the will of the late Mr. Gordon McKay, inventor of the sewing machine that bears his name, Harvard University receives a very large bequest for applied science, estimated to be about 800,000*l*., and eventually much more. We learn from *Science* that according to the terms of the will, Harvard University is to receive 200,000*l*. when this amount has accumulated from the income, and is thereafter to receive 80 per cent. of the balance of the income after annuities have been paid, and is to receive the entire residue of the estate after the death of the last surviving annuitant. The portion of the will defining the object of the bequest is as follows:—The net income of said endowment shall be used to promote applied science. First, by maintaining professorships, workshops, laboratories and collections for any or all of those scientific subjects which have, or may hereafter have, applications useful to man; and, second, by aiding meritorious and needy students in pursuing those subjects, especially in connection with mechanical engineering. *Science* also states that under the will of Sarah B. Harrison, Yale University is given 20,000*l*. in memory of her brother, the late Gov. Henry B. Harrison, of Connecticut, who for thirteen years was a member of the Yale Corporation. The money is given in trust, the income to be used for such purposes as the university shall desire.

A BILL to carry out the recommendations of the Universities Commission, those recommendations having been accepted by the Government of India after consultation with the local administrations, was introduced by the Hon. Mr. Raleigh on November 4 to the Supreme Legislative Council of India. We learn from the *Times* that the Bill reduces the number of ordinary fellows to 100 in the case of the senior universities, and to 75 in the cases of the Allahabad and Punjab Universities. The "syndicate" is also to be reduced in membership, so as to make it a compact working body, to be recognised as the executive authority of the university entrusted with certain powers independently of the Senate. The existing members of the Senate will be continued merely as honorary fellows, and be divested of any share in the active business of the university, excepting the right to vote for legislative or municipal representatives. The privilege of electing fellows will be maintained in cases where it exists. It will be for the Government to decide as to the extension or withdrawal of the affiliation of colleges, the function of the university in this respect being merely advisory. Sir Denzil Ibbetson announced that, with the approval of the Secretary of State, it had been decided to make for five years special grants-in-aid to universities and colleges the claims of which to special assistance in carrying out the contemplated reforms are established.

DR. FREDERIC ROSE, His Majesty's Consul at Stuttgart, has made another report to the Foreign Office on technical instruction in Germany. This report is published as No. 600 in the miscellaneous series of diplomatic and consular reports, and is concerned with the building and engineering trades' schools, the aims, organisation and equipment of the Baugewerkschulen being described. Dr. Rose gives very instructive accounts of the schools of this kind in Stuttgart, Karlsruhe, and Nuremberg, and concludes with a history of the development of similar technical institutions in Prussia. These building and engineering trades' schools play an important part in German technical education, being intended, not to train captains of industry, but rather subaltern officers and the rank and file of the industrial army. The schools are in some cases State schools, in others municipal schools. In Prussia nineteen out of twenty-two existing are State schools. The instruction is given both in winter and summer in some schools, in others during the winter months only. It varies to a certain extent at the various schools, both as regards duration and extent. For example, Prussian schools possess four classes of half a year each for building, whilst Nuremberg possesses five, and Stuttgart and Karlsruhe six classes for the same purpose. As illustrative of the aims of these schools, reference may be made to that at Stuttgart, where in the building departments instruction suitable for the following workers is given:—practical master builders, subordinate building officials, road and street inspectors, fire prevention inspectors, railway inspectors, and hydraulic engineering *techniker*; in the mechanical engineering department to managers of workshops and factories, overseers, machine draughtsmen, &c.; and in the surveying department to public surveyors and drainage and irrigation supervisors.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, November 19.—"On the Rapidity of the Nervous Impulse in Tall and Short Individuals." By Dr. N. H. **Alcock**. Communicated by A. D. Waller, M.D., F.R.S.

While the effect of varying conditions on the rapidity of transmission of the nervous impulse has been fully studied, no research has yet been made as to whether the stature of the individual and the corresponding difference in the lengths of homologous nerves have or have not any influence on this rapidity, and as recent work has rendered it desirable that the question should be considered, the research here recorded was undertaken to this end.

Two series of observations were made:—(1) On the frog; (2) on man.

The results lead to the following conclusions:—

(1) The rapidity of the nervous impulse *per unit length* is the same whatever be the stature of the individual.

(2) The time taken by this impulse to travel from the centre to the periphery is greater in taller individuals.

(3) The nodes of Ranvier exercise no influence on the rate of impulse.

Physical Society, November 27.—Dr. R. T. Glazebrook, F.R.S., president, in the chair.—Mr. Horace **Darwin** exhibited an electric thermostat. The thermostat shown at the meeting was made for Lord Berkeley, and is similar to one made for the spectrograph of the 24-inch refractor of the Royal Observatory, Cape of Good Hope. The vessel the temperature of which is to be maintained constant is surrounded by oil contained in a bath. In the oil are placed two heating-coils, through which electric currents pass. By automatically controlling these currents the temperature of the oil, and consequently of the inner vessel, is kept very nearly constant. The control is effected by means of a Wheatstone-bridge in the outer oil-bath. This bridge has two opposite arms of copper and two of manganin, so that it is only balanced at some definite temperature. Its deviations from balance affect the position of a long horizontal boom attached to the suspended coil of a galvanometer. The position of the boom determines the greater or less descent of a "hit or miss" arm which is periodically raised by a rotating-cam, and can only fall to its lowest position when the galvanometer-boom is to one side and allows it to pass; this position of the boom corresponds to a fall of temperature of the controlling-bridge. Thus the position of the "hit or miss" arm at its lowest position depends on the temperature, and it is the variation of this position which regulates the amount of current passing through the heating-coils. The thermostat supplied to the Cape Observatory is capable of keeping the temperature within 1/100° C. for a period of eight hours.—On the occurrence of cavitation in lubrication, by Mr. S. **Skinner**. The experiments described in the paper arose from an observation made when determining the refractive index of a liquid by means of Newton's rings. As Newton showed, the rings can be obtained when a liquid is run into the space between the lenses. If when the liquid has been introduced the upper lens be rolled on the lower, the observer sees following the central dark spot a crescent-shaped space, very bright provided the illumination be sufficiently oblique. This is a vacuous or vapour-filled space, for when the motion of rolling ceases the liquid flows into the space and completely fills it. The inflow of the liquid depends in some way on the viscosity, and the effects are more pronounced when a more viscous liquid is used. The most convenient mode of observation is to use a deeply-coloured liquid, and to look at the space by transmitted light. The author has found that a convenient liquid is a strong solution of fuchsin in glycerin. The cavities which are formed must be produced either by splitting the liquid itself or by tearing the liquid from the glass surface. The effect may be described as a case of "cavitation." Some experiments were made to imitate the actual case of a fully lubricated axle rotating under a bearing. In ball-bearings completely immersed in oil, the experiments show that there must be a small cavity near the point of nearest approach of each ball to its neighbours, and also to the surface on which it is running. As the friction of the bearing is the viscous friction of the oil, it follows that the friction must be considerably reduced by the formation of these cavities, which are filled with relatively non-viscous vapour. The high lubricating property of oils owes its origin not only to their superior viscosity, but also, possibly, to the facility with which cavities may be formed in them.—Prof. R. **Threlfall** exhibited and described the following instruments which he has used in the testing of electric generators by air calorimetry:—(1) A "hot-wire voltmeter" accurate to 1/100 volt. The wire in this instrument is very fine, and special precautions are taken to keep the tension on it constant, so that the elongation measured is due only to the expansion of the wire caused by the heating effect of the current. (2) A "Pitot tube" for the measurement of air velocity, the velocity being proportional to the square root of the pressure produced in the tube. (3) A "manometer" for determining pressure differences in Pitot tubes with accuracy. This consists essentially of two bottles containing coloured water, which are connected by a syphon, and the air-space of each bottle is put in communication with

its appropriate tube. The readings are taken by setting a pair of needle-points just to touch the liquid surface, and then measuring how they differ in level by micrometer screws, or by callipering suitable jaws. The instrument is trustworthy to 0·01 mm. of water-pressure. (4) A multiplying pressure-gauge in which the motion of a float or ball is used to operate a finger moving round a dial. The dial is divided in such a manner that the square roots of the pressure-differences are read off. Air velocities are therefore given directly.

Geological Society, November 4.—Sir Archibald Geikie, F.R.S., vice-president, in the chair.—Metamorphism in the Loch-Lomond district, by Mr. E. Hubert **Cunningham-Craig.** The area dealt with includes all the Highland rocks on either side of the loch, as well as the area lying to the eastward. Each stage of the progressive metamorphism can be studied without confusing its effects with those of another process. The rocks from the Leny-Grit group and the Aberfoil-Slate group show dynamic metamorphism, and at Rudha Mor the beginning of the thermal type is seen. This is superseded by a constructive metamorphism, probably of hydrothermal type, and the rocks become more highly crystalline, until all clastic structures are obliterated. The segregation of like minerals into folia, the total recrystallisation, and the genesis of new mineral-groupings, result in the production of coarsely-crystalline albite-gneisses from siliceous and felspathic grits.—On a new cave on the eastern side of Gibraltar, by Mr. H. D. **Acland.** This cave is situated south of the eastern end of the tunnel, which pierces the Rock from the dockyard on the western side to "Monkeys' Quarry" on the eastern. The main hall is about 70 feet high and 45 feet wide, and has a smooth stalagmite floor resting on breccia, and a stalactitic roof covering the limestone of the Rock. Its floor falls to a point 19 feet above sea-level. The lower gallery descends at its far end to little short of sea-level. Its floor consists of stalagmite resting on calcareous sand; this on coarse sand, followed by rubbly and calcareous grit, which in time rests on the rock-floor at a depth of 15 feet. In the calcareous grit are well-rounded stones, some pierced by pholades. At a depth of 13 feet were echinids and barnacles. Two other galleries were explored, and in these the walls are pitted to a height of 28 feet above sea-level. The author concludes that the cave existed at first as a fissure, to which the sea obtained access for a long period, and during this period the rock was elevated some 42 feet. The cave was closed to the sea at a period geologically recent, and the breccia and sand-slopes date from a still more recent period.

Linnean Society, November 5.—Prof. S. H. Vines, F.R.S., president, in the chair.—Dr. W. G. **Ridewood** exhibited the frontal bones of a horse showing rudimentary horns. The bony protuberances were about three inches apart, and were set upon the curved ridges that constituted the anterior margins of the areas of origin of the temporal muscles. In the natural sloping position of the head in the living horse they would have been vertically above the orbits. Dr. Ridewood pointed out that the exceptional cases of horny bosses occurring in horses could hardly be regarded as instances of reversion, for the palæontological record of the evolution of the horse is remarkably complete, and no indications of horns are to be found in the extinct congeners of the modern equines.—Prof. **Weiss** exhibited some preparations and photographs of a mycorhiza or mycorhizome from the Coal-measures. The preparations were in part from the Cash collection at the Owens College, Manchester, and in part from Dr. Scott's private collection. They showed the existence in a small root-like organ of fungal filaments presenting all the appearances of those found in the roots of many orchids and in the rhizome of Psilotum.—Mr. B. H. **Bentley** exhibited a large series of lantern-slides, designed for teaching purposes, which he had taken, illustrating certain types of floral pollination, and bees and other insects in actual operation.—Mr. L. A. **Boodle** read a paper on the structure of leaves of the bracken, *Pteris aquilina*, in relation to environment. It is well known that in dry exposed situations the bracken produces leaves of a hard dwarf habit, while in very sheltered localities the leaves are quite soft. This difference in external characters is accompanied by a difference in structural characters. The exposed leaf has a hypoderm, and is a distinctly xerophytic "sun-leaf"; the other type of leaf is a pronounced "shade-leaf," having no hypoderm, and weakly developed palisade-tissue or no definite palisade. A similar difference may occur in different leaves of the same plant, or in different parts of the same leaf when shelter and exposure are sufficiently localised. A slightly xerophytic plant, when transferred to a greenhouse, produced shade-leaves only (though the illumination was fairly strong), and in these leaves the indusia were considerably reduced. The bracken is thus very plastic in its relation to environment.—A paper by Mr. E. P. **Stebbing**, on the life-history of a new Monophlebus from India, with a note on that of a Vedalia predaceous upon it; with remarks on the Monophlebinæ of the Indian region, was, in the absence of the author, read for him by Mr. G. S. Saunders. Up to 1901 only five species of the genus Monophlebus were known as Indian, and four of these were described from the male insect only; in that year the writer discovered both sexes of two new species, which had been named by Mr. E. Ernest Green, Government entomologist, Ceylon, *Monophlebus Stebbingi* and *M. Dalbergae*, whilst a third species, of which the females alone are known, was named *M. Tectonae*. These coccids infest forests in large numbers, and in consequence their ravages are serious. The amount of nutriment withdrawn from the trees is extraordinary, and the extruded sugary fluid may be heard falling like rain in an infested forest. The predaceous *Vedalia Guerinii*, Crotch, was then described, and its method of attack and great voracity; in turn, it is parasitised by a small fly whilst in the larval stage.

PARIS.

Academy of Sciences, November 25.—M. Albert Gaudry in the chair.—The relation between sun-spots and terrestrial magnetism. The utility of continual registration of the variable elements of the sun, by M. H. **Deslandres.** After a critical examination of the various hypotheses which have been put forward to connect solar phenomena with magnetic storms, the conclusion is arrived at that the solution of the problem has not yet been reached.—On the geological significance of anomalies in gravity, by M. **de Lapparent.** It is generally accepted that gravity is in excess of the average in oceanic regions, and is below the average on land. The suggestion is made, in opposition to the views of M. Faye, that the observed anomalies are due rather to the effect of dislocation than of the low temperature of the ocean floor.—On the reinforcement of the action of the bundle of light rays upon the eye, when accompanied by the *n*-rays, by M. R. **Blondlot.** It has been shown in previous papers that a feebly illuminated object increases in brightness when the *n*-rays are allowed to fall on it. It has now been found that if the *n*-rays are directed towards the eye instead of the object, a similar reinforcement is observed.—M. Émile Bertin was elected a member in the section of geography and navigation in the place of the late M. de Bussy.—On functional equations and the theory of divergent series, by M. L. **Fejer.**—On a system of three functions of real variables, by M. **Pompieu.**—On the possibility of sustaining in the air an apparatus employing a helix, using an internal combustion motor, by M. Charles **Renard.** The reduction in the weight of an internal combustion motor per horse-power developed, now brought as low as 2·5 kilograms per horse-power, renders possible the use of a light helix in an aërostat. The theory is given for the conditions necessary in practice.—On the measurement of the effect of electric waves at a distance by means of the bolometer, by M. G. **Tissot.** The use of a bolometer as a detector has given readable results at a distance of 40 kilometres. The most advantageous arrangement of the apparatus has been worked out experimentally.—On the colour of aqueous solutions of methyl orange and the change produced by acids, by M. P. **Vaillant.** Simultaneous observations of electrical conductivity and molecular absorption (measured with the Gouy spectrophotometer) show that neither the theories of Ostwald nor of Küster are completely in accord with fact. The results point to a progressive molecular transformation of methyl orange under the action of acids, the change being more rapid with the stronger acids.—The modes of deformation and fracture of iron and mild steel, by MM. F. **Osmond**, Ch. **Frémont**, and G.

Cartaud.—Influence of the gases on the separation of metals by electrolysis: the separation of nickel and zinc, by MM. **Hollard** and **Bertiaux.** The introduction of a sulphite, preventing the evolution of oxygen at the anode, permits of the easy separation of nickel from zinc by electrolysis. Experimental analyses are given.—On oxalacetic acid, by M. L. J. **Simon.** The ether is treated with concentrated hydrochloric acid; the free acid, which is insoluble in this liquid, separates completely in about forty-eight hours.—The condensation of the salts of dinaphthopyryl with phenols, by M. R. **Fosse.**—The synthesis of nicotine, by M. Amé **Pictet.** Starting with nicotinic acid, this is converted into β-aminopyridine, the dry distillation of the mucate of this base giving a N-pyridyl-pyrrol. The vapours of this substance, passed through a red-hot tube, give α-pyridyl-pyrrol, which is methylated, giving the isodipyridine of Cahours and Étard (the nicotyrine of Blau). This gives inactive nicotine on suitable reduction, and from this an alkaloid identical in all respects with natural nicotine was obtained in the usual way with dextrorotatory tartaric acid.—The morphogenic action of water in motion on hydra, by Mme. S. **Motz-Kossowska.**—On the function of certain figured elements in *Sipunculus nudus*, by M. F. **Ladreyt.**—On the medusa of Victoria Nyanza, by M. Ch. **Gravier.**—On a double fusion of the membranes in the zygospore of Sporodinia, by M. Paul **Vuillemin.**—On a bacterial disease of the beetroot causing yellowing, by M. G. **Delacroix.** This disease attacks both the forage and sugar beet; practical suggestions are given with a view to its prevention.—On the formations of the zone of quartzites and conglomerates below the Devonian in the Northern Urals, by MM. L. **Duparc** and F. **Pearce.**—On the structure of the Hohe Tauern, in the Tyrolese Alps, by M. Pierre **Termier.**—Contribution to the study of the sodic rocks of East Africa, by M. H. **Arsandaux.**—The volcanic rocks of the island of Eubea, by M. **Deprat.**—The morphogenic action of crotaphytic muscles on the skull and brain of the Carnivora and Primates, by M. R. **Anthony.**—Comparison between the nervous effects of the Becquerel rays and those of light rays, by M. Georges **Bohn.** The action of radium rays upon the teguments is very complicated, acting upon the peripheral nervous filaments, producing a kind of anæsthesia.—On the existence in the animal organism of a diastase possessing simultaneously both oxidising and reducing actions, by MM. J. E. **Abelous** and J. **Aloy.**—On the marsh gas fermentation and the ferment which produces it, by M. **Mazé.** From a fermenting mass of dead leaves a specific organism has been isolated capable of producing methane during the fermentation of suitable solutions.—On tuberculins, by M. **Beraneck.**—A Crookes bulb for radiotherapy, by M. **Audin.** A description of an X-ray tube specially adapted for the treatment of cancer of the mouth and throat.

DIARY OF SOCIETIES.

THURSDAY, DECEMBER 3.

ROYAL SOCIETY, at 4.30.—On the Fructification of *Neuropteris heterophylla*, Brongniart: R. Kidston, F.R.S.—Histological Studies on Cerebral Localisation: Dr. A. W. Campbell.

LINNEAN SOCIETY, at 8.—On Littoral Polychæta from the Cape of Good Hope: Dr. Arthur Willey, F.R.S.—Notes on *Myriactis Areschougii* and *Coilodesme californica*: Miss May Rathbone.

RÖNTGEN SOCIETY, at 8.30.—The Production of Photographic Reversal under the Combined Action of various Radiations: C. E. S. Phillips.

AËRONAUTICAL SOCIETY, at 8.—Report of the International Kite Competition—(1) Mathematical Portion: Prof. C. V. Boys, F.R.S.; (2) Descriptive Portion: Eric Stuart Bruce.—Preliminary Communication on the Longitudinal Stability of Aëroplane Machines: Prof. G. H. Bryan, F.R.S., and W. E. Williams.—The Balloon Ascents made by the late Mr. James Glaisher, F.R.S., for Scientific Purposes: W. Marriott.—The Mechanical Imitation of Bird Flight: W. Cochrane.

CHEMICAL SOCIETY, at 8.—On the Molecular Formulæ of some Fused Salts as Determined by their Molecular Surface Energy: J. F. Bottomley.—Acid Salts of Monobasic Acids: R. C. Farmer.—The Atmospheric Corrosion of Zinc: G. T. Moody.—The Solubilities of the Hydrates of Nickel Sulphate: B. D. Steele and F. M. G. Johnson.

FRIDAY, DECEMBER 4.

GEOLOGISTS' ASSOCIATION, at 8.—On Land, Freshwater and Estuarine Deposits, with Special Reference to Recent Excursions; Lecture by the President, Mr. H. W. Monckton.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Artificial Draught, as Applied by Fans to Steam Boilers: W. H. A. Robertson.

MONDAY, DECEMBER 7.

SOCIETY OF ARTS, at 8.—The Mining of Non-Metallic Minerals Bennett H. Brough. (Cantor Lectures. III.)

FARADAY SOCIETY, at 8.—Total and Free Energy of the Lead Accumulator: Dr. R. A. Lehfeldt.—Bitumen in Insulating Compositions, Part i.: D. A. Sutherland.—Notes on Aluminium Welding: Sherard Cowper Coles.—Electrochemical Installation at the Borough Polytechnic Institute: Dr. F. M. Perkin.

TUESDAY, DECEMBER 8.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Discussion of Paper on the Distribution of Mean and Extreme Annual Rainfall over the British Isles: Dr. H. R. Mill.

WEDNESDAY, DECEMBER 9.

SOCIETY OF ARTS, at 8.—Furnaces suitable for Jewellers' Work, Enamelling, Art Casting, and other Similar Industries: Henry H. Cunynghame.

THURSDAY, DECEMBER 10.

MATHEMATICAL SOCIETY, at 5.30.—Proof of a Formula in Elliptic Functions: Mr. R. J. Dallas.—On Many-valued Newtonian Potentials: Prof. A. C. Dixon.—A Generalisation of Neumann's Expansion of an Arbitrary Function in a Series of Bessel's Functions: Rev. F. H. Jackson.—Modes of Convergence of Infinite Series of Functions of a Real Variable: Dr. E. W. Hobson.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Presentation to representatives of the Borough of Colchester of a historical picture representing Dr. Gilbert in the act of showing his electrical experiments to Queen Elizabeth and her Court.—The Slow Registration of Rapid Phenomena by Strobographic Methods: the "Ondographe" and "Puissancegraphe" (Wave Recorder and Power Recorder): M. E. Hospitalier.—The Magnetic Dispersion in Induction Motors, and its Influence on the Design of these Machines: Dr. Hans Behn-Eschenburg.

SOCIETY OF ARTS, at 4.30.—India's Place in an Imperial Federation: J. M. Maclean.

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