THURSDAY, DECEMBER 19, 1907.

MATHEMATICS IN BOTANY.

Mathematische und mikroskopisch-anatomische Studien über Blattstellungen. By Dr. G. van Iterson, Jun. Pp. xii+331+plates. (Jena: G. Fischer, 1907.) Price 20 marks.

THE subject of Phyllotaxis, which formerly involved the study of the arrangement, though now more particularly the mode of origin, of the lateral members of a plant-shoot, since it was first placed on a scientific footing by Bonnet in 1754, has afforded one of the most fascinating branches of botany, and, it must be frankly admitted, one which is very inadequately treated in text-books; this being again the expression of the fact that the more that is known with regard to it, the more complex do its problems appear, and the more hopeless of final solution. The subject, again, possesses possibly a special interest in that it is strictly non-utilitarian, and remains a field of abstract scientific work dealing with some of the most fundamental questions of protoplasmic life, which attain but little emphasis in the animal kingdom, owing to the restricted output of systems of ramification and appendage-production in the more condensed type of animal-organisation. The literature of the subject is, however, very voluminous, and slowly increases, the present volume of Iterson being the only important contribution since the loss of Schumann, and the publication of some of the work of Church (1904).

In that the arrangement of lateral members in the case of shoot-construction usually involves phenomena of periodicity or rhythm, phyllotaxis becomes capable of a certain amount of mathematical treatment; and it is to this fact, perhaps, more than to any other that the subject is often viewed with a vague distrust by the majority of botanists; mathematical results can only follow from given premises, which must first be interpolated into the question; for example, Church pointed out in 1901 that the accepted usage for seventy years of mathematical expressions based on systems of regular helices rendered all discussions of the arrangement of members on growing apices purely nonsensical, and vitiated all deductions based on the apparent imperfection of such constructions. Some working hypothesis is clearly necessary to start with, and the assumption of different data may involve a completely different mathematical presentation. Iterson's volume, including 300 pages on the botanical aspect of the question, devotes 190 to mathematical speculations, the greater part of which will therefore not appeal to the average botanist at all. The mathematician necessarily starts with a severe handicap, since the data of the actual appearances presented at the apex of a vegetative shoot are so illusive. New primordia rise up as rounded pimples, wholly independent of the segmentation of the apex into constituent cells, and often without any visible connection with each other, yet falling along the paths of what is often a very elaborate pattern, most readily defined as a meshwork of intersecting radiating curves; and it is admittedly impossible to measure any lines or angles, or even to plot the form of the actual primordium with any such degree of accuracy as a precise mathematical presentation would appear to demand; hence observers who are more familiar with the conditions obtaining at a growing-point become naturally suspicious of mathematical speculations which are incapable of verification.

In all the speculations which have been introduced into the subject, the difficulty is to find anything whatever which can be established as a reasonable proof of the working hypothesis selected; thus in Dr. Iterson's volume, models of spheres in helicoid or conical arrangements may edify the beginner, but they have no particular relation to the origin of leaf-primordia on the surface of a shoot-apex; systems of circles in tangential contact must remain unsatisfactory while there is no evidence that primordia can be treated as circles, or that the tangential contact is absolute; the mathematics of a conical surface which can be unrolled has little reference to the curved dome of a plant-shoot, the curve of which is beyond present calculation, while any unrolling of the systems destroys the only essential feature of the system of intersecting curves; again, the projection of a spherical primordium to a "folioid" curve gives suggestive imitative results, when these folioid curves are continued in a log. spiral system; but there is no evidence to connect the folioid with the shape of a leaf-primordium; and it does not, as a matter of fact, fulfil the normal demands of a phyllotaxis-system.

Writers on phyllotaxis in the past may be divided into three categories: first, those who seek merely for a method of simply enumerating and cataloguing the phenomena observed in the beautifully rhythmic patterns, usually expressed as spiral curves, in plant-shoots and buds, familiar examples of which are observed in the Pine-cone and the arrangement of the disk-florets of Composites. For these the empirical helical formulæ of Schimper and Braun (1835) still afford a sufficient basis, so long as observations are restricted to adult structures, and no very rigid accuracy is required. A second class of writers start off on the attempt to *imitate* the appearances, hoping thereby to explain them; the most unscientific line of approach conceivable, the physiological fallacy of such mimetic methods having been fully exposed by Sachs. To this line of argument botany is indebted for numerous theories of "torsion," since torsion will give a spiral effect! Such imitative conceptions culminate in the contact-pressure theory of Schwendener. Lastly, there is a more modern class of investigators who require something more fundamental, in the nature of a physical cause for the phenomena of rhythm, which clearly lies behind the first visible rise of rounded primordia, these being but the expression of more concealed growth-factors.

The treatise of Dr. Iterson, who apparently remains in the imitative line of approach, may be briefly described as an attempt to harmonise the largely accepted theories of Schwendener and older writers with a corrected mathematical presentation which in itself renders the difficulties of these writers largely illusory; as in the case of these observers, Iterson gets little

further than the expression of certain facts of general observation, which in themselves constitute no proof. Schwendener's theory of the influence of mechanical contact has long held the field, in spite of the fact that no such contact can be invariably proved to exist, or even to exert any mechanical action; so much so, in fact, that it has been regarded as possible to dilute the theory to one of vague "stimulation." Dr. Iterson, by following along the well-worn paths of previous observers, has reached very similar conclusions; and it must be admitted that continual study of the best exhibitions of the uniform construction of vegetative shoot-systems naturally impels the observer to the old and familiar view of Hofmeister, that appendages cannot help themselves, but arise in the next "widest gap" between pre-existing ones, as they are seen to do; such a statement represents no solution of the problem, but is, in fact, a confession of failure.

On the other hand, by approaching the subject from the standpoint of floral ontogeny, in which the most complex phyllotaxis-systems can be observed developing before one's eyes according to a perfectly defined architectural plan, in which the relation of the individual members may, however, be practically anything whatever, wide gaps being left in some places, spirals mixed with circular construction, and members apparently "omitted," as well as appearing "out of their turn," an investigator equally inclines with Schumann to the view that contact-relations present no contributory cause whatever to the phenomena of the initial phases, which can only be referred to autonomous growth-impulses within the substance of the shoot-apex; a region which, consisting as it does of undifferentiated cell-units, is beyond further possibility of observation. Among the general conclusions for straightforward "constant-phyllotaxis," Iterson reiterates the stock considerations of "bulk-ratio," "contact-relations," and the principle of the "widest gap" (p. 291).

The fallacy of the widest gap has been exposed over and over again; it is sufficiently obvious to the unprejudiced eye in the appearances presented at the apex of the common Fern, or shoots of Water-lilies; primordia do not invariably arise in close contact with each other, but may be widely spaced out at first. The same want of contact, or any connecting sequence between one series of members and the next, is a common phenomenon in floral ontogeny which also includes cases of such absolute irregularity that the necessity for a "mechanical law" for their production becomes an absurdity; while in examples of perfect regularity of construction, the case of extreme mathematical interest centres in those few instances in which successive whorls do not fall into the gaps of their predecessors at all, but are accurately superposed; such cases occur in certain living species of Mesembryanthemum, though the significance of this formation in the case of fossil plants may still be open to question. It is thus a matter for regret that Iterson should revive the conceptions of "close-contact" and "widest-gaps," which have seen so much service in the past; while again the conception of "bulk-ratio," or the relative size of the primordium with regard to the axis on which it is "inserted," though extremely useful in dealing with the difficulty of distinguishing between systems which involve numerals of the same summation series, *e.g.* 3 : 5 : 8, &c., can yield no practical solution of the difference, for example, between a 3 : 5 construction and a 3 : 4, or, again, of the essential difference between spiral and circular arrangement. It is also sufficiently obvious that the causes which determine the relative rates of growth (which lie behind the relative size) must have existed in the actual substance of the growing-point some time before the primordia became visible to the eye as a definite outgrowth, and, admitting the absence of any necessity for close-contact, the spacing of the new centres of growth is presumably more important than their actual size; once the centres are initiated, the new growth-impulses from them are continued until they ultimately make lateral contacts as a wholly secondary phenomenon.

Dr. Iterson's volume affords an admirable introduction to the subject, and most of the branches are indicated; considerable value attaches to the *résumé* of the theories of Schwendener and Celakovsky, copiously illustrated with excellent figures (more than 100 text-illustrations, and 16 plates); these bear sufficient witness to the enthusiasm of the author in this most absorbing field of speculation, though when all is said we appear to be no nearer the solution of the problem than ever; it only gains in complexity where it seems to be most regular and simple; since an absolutely irregular construction can clearly have no explanation at all, it simply grows as one sees it grow, and can neither be accurately described nor imitated. To those who seek for the inner and ultimate cause of the phenomena, the subject still presents an indefinite field of research.

Few botanists appear to realise the extent to which a proper appreciation of the subject of phyllotaxis is involved in the morphological consideration of plant-growth, and floral construction and even phylogeny; the marvellous standpoint that a dimerous flower is simpler, and therefore more primitive, than a trimerous one, and a trimerous than a pentamerous, constitutes one of the vitiating factors of the systematic work of Eichler, and is still reflected in the modern German school of classification.

ORGANIC CHEMISTRY FOR MEDICAL STUDENTS.

Text-book of Organic Chemistry for Medical Students. By Dr. G. v. Bunge. Translated with additions by Dr. R. H. A. Plimmer. Pp. ix + 260. (London : Longmans, Green and Co., 1907.) Price 6*s.* net.

THE rapid advance which has marked the progress of physiological chemistry in the last twenty years, owing mainly to the remarkable researches of Prof. Emil Fischer, has emphasised the necessity of a sound knowledge of organic chemistry for all students of medicine. But organic chemistry has undergone developments in many other directions, and new compounds have multiplied at a most bewildering rate. It is clearly undesirable for the student of medicine to become acquainted with any

large proportion of the hundred thousand compounds which organic chemistry is said to include. He might, after a firm foundation had been laid, study with advantage only those special subjects which come within his sphere of interest. He cannot very well know how to select these for himself, and Prof. Bunge has therefore attempted to do it for him.

On the whole, Prof. Bunge has been very successful in the choice and arrangement of his materials, and has produced an eminently readable book. But the task cannot have been an easy one. In a small volume of 250 pages, which is assumed to start with the rudiments and finishes with such complex vital products as the purines, the proteins, and the alkaloids, there is a danger that the treatment may be diffuse and superficial. But though this is certainly not the case, it must be confessed that some preliminary knowledge of analysis, molecular-weight determinations, and especially about methods of studying structure, is desirable, if not indeed necessary, if the subject is to be understood. In support of this it may be pointed out that the structural formula of oxalic acid is given on p. 2, of glyceric aldehyde and dioxyacetone on p. 5, and of hippuric acid on p. 8, without any previous reference to Kekulé's structural laws. But this appears to be the only serious defect, and one which the student can easily remedy by a little preliminary study.

The chapters are written in a manner well calculated to stimulate the reader; indeed, no organic text-book within the writer's knowledge is so full of human interest. The following few errors have been noted:—Chlorine does not convert aldehyde into chloral, but mainly into butyl chloral (p. 50). It is not true that "no one has yet succeeded in obtaining directly by synthesis either a *d*- or a *l*-compound" (p. 79). On the contrary, *asymmetric synthesis* is an accomplished fact. A racemic compound and a mixture of enantiomorphs are not synonymous, and the difference is indicated by *r* and *dl* (p. 89). The author refers to the separation of synthetic tartaric acid into its *d*- and *l*-components by Jungfleisch as causing a great sensation, "for up to that time many chemists thought that optically active compounds could only be formed by the living cell" (p. 89). There must surely be some confusion here, for did not Pasteur resolve racemic acid? Pasteur, it is true, considered asymmetric synthesis, or the formation of one enantiomorph without the other, as a peculiar property of living matter, but that is another thing altogether. Finally, on p. 147 occurs the old story of Wöhler's discovery of artificial urea in 1828, a date which tradition and the text-books have fixed upon as that of a two-fold event—the first organic synthesis and the downfall of the vital-force theory. In reality it was neither the one nor the other, and perhaps the following observations may help to put the matter in a clear light.

The preparation of natural products in the laboratory began before Wöhler was born, for in 1776 Scheele obtained oxalic acid by oxidising sugar. Doebereiner's preparation of formic acid from tartaric acid in 1822, and Hennel's synthesis of alcohol from olefiant gas were both prior to Wöhler's discovery. That Doebereiner's discovery received contemporary recognition is evident from Berzelius's reference to it in the *Jahresbericht* for 1823. "Doebereiner," he says, "has made the remarkable discovery that formic acid may be produced artificially." Now Liebig, in his treatise of 1840, falls into a curious error, which may lie at the bottom of the text-book myth. In reference to formic acid he writes, "Doebereiner was the first who prepared it by chemical means," whilst in another place he says, "Woehler found a way of obtaining urea artificially, and it was the first substance formed in the animal-life process which had been successfully reproduced by chemical means." Now formic acid is as much a product of the animal-life process as urea, and no real distinction can be drawn between them.

It is clear, therefore, on Liebig's own showing, that of the two artificial products, Doebereiner's has the prior claim. How little Wöhler's discovery served to remove the belief in a vital force is very clearly indicated in Gerhardt's "Précis de Chimie Organique," published in 1844.

"A number of animal and vegetable substances have been reproduced by acting with oxygenating agents on more highly carbonised compounds . . . thus, the chemist has followed a path entirely opposed to that pursued by vegetable life . . . one need not therefore feel astonished that he has not yet produced cerebral matter, nor the constituents of the blood, nor equally complex substances."

Thus the vital-force theory did not suddenly collapse, as generally stated; on the contrary, it died a slow and lingering death. We may, indeed, ask, is it quite dead yet? For to quote the words of an authoritative contemporary writer, "the testimony of pure chemistry cannot as it at present stands be legitimately interpreted into a direct negation of vitalism in any form."

There only remains to add a reference to the work of the translator. Dr. Plimmer has not only rendered the German into excellent English, but has added very considerably to the text. J. B. C.

OUR BOOK SHELF.

(1) *Some Nature Biographies: Plant, Insect, Marine, Mineral.* By J. J. Ward. Pp. xvii+307; illustrated. (London: John Lane, 1908.) Price 5*s.* net.

(2) *The Fairyland of Living Things.* By R. Kearton. Pp. viii+182; illustrated. (London: Cassell and Co., Ltd., 1907.) Price 3*s.* 6*d.*

(1) MR. WARD'S little work, which consists of a series of articles originally published in the *Strand, Pall Mall, English Illustrated,* and other magazines and periodicals, may be regarded as a kind of kinematograph in book form, and may be unreservedly commended to all nature-lovers. One great feature of the several life-histories is that they are in the main based on actual personal observation, and that, too, of a kind which demands constant attention and the expenditure of no inconsiderable amount of time. In his preface the author very modestly suggests that he is entitled to the credit of being the pioneer in certain forms of insect photography, and to this credit, so far as our information goes, he is fully entitled. Nothing in nature-photography can, indeed, be more interesting than his pictures of the sequence of events which herald the complete liberation of the butterfly or the moth from its chrysalis,

or of the marvellous evolutions of the caterpillar of the swallow-tail when about to pupate. As the author very pertinently remarks, to obtain photographs of this description the artist has in most cases only a single brief opportunity; and if one single link in the chain be missed, the whole series of pictures is spoilt. Needless to say, the reader sees only the successes; the failures are labour lost.

Among such an excellent series, it is difficult to select particular figures for mention, but those of the white admiral butterfly are especially noteworthy. Equally instructive and interesting are the photographs of developing and retrograding vegetable-life; more especially those connected with the fall of the leaf—a progress of which comparatively few persons know the physiological history.

The senses of insects, illustrated with exquisite pictures of antennæ and the fly's "tongue," form another chapter. The book closes with 12 photographs representing the monthly changes in a landscape as seen from one particular spot—a fuller development of the idea of photographing particular trees in summer and again in winter. A better book of its class we have never seen.

(2) In the "Fairyland of Living Things" Mr. R. Kearton, aided, as usual, by his brother's camera, offers an attractive Christmas book, which should delight many households of young people. In place of confining himself to birds, the author includes in his purview quadrupeds (both hot- and cold-blooded), insects, and plants, and endeavours to interest his *clientèle* by dwelling on habits, instincts, and character rather than by describing structural details. Whether the author has touched the right note must be left for the class of readers to whom he appeals to decide; but we have never yet seen a "Kearton book" that has not proved a success. R. L.

Physiologisches Praktikum für Mediziner. By Prof. Max Verworn. Pp. xii+262; illustrated. (Jena: Gustav Fischer, 1907.) Price 6 marks.

THE practical class in physiology as known in this country has never been adopted to the full in Germany. There each student works out his own salvation by independent laboratory work, and research is started at an early stage in his career, as a means to teach him methods and resource. Elaborate German handbooks have been written as guides to such workers, most of them dealing with one branch of physiology, and not with all.

The aim of Prof. Max Verworn has not been to write an ambitious work of this character, but to furnish the average medical student with a guide to certain fundamental exercises, most of which it ought to be possible for each one to perform for himself, possibly in a class, as is the English custom. The remainder are appropriate for demonstrations.

In such a book it is obvious that there should not be over-specialisation, and thus we find in the subject, say, of the blood the study of its circulation closely following on that of its chemistry. In this way the various chapters see-saw between chemical and physical matters. In a theoretical book this is an ideal plan, but for a practical guide it has its drawbacks. Prof. Verworn is so well known for his writings on cells and what he terms "general physiology" that it is not surprising to find that some of the opening pages deal with this branch of science, and simple exercises on galvanotaxis, chemotaxis, and the like are introduced.

In some cases the directions are purely practical, and the descriptions of certain simple dissections are most precise. In other cases, theoretical matter and explanations are interspersed. These necessarily deal with the subject very briefly, and the very briefness is in some cases apt to cause bewilderment. The description of the causes of blood coagulation cannot possibly be clearly given in a single short paragraph.

On the practical side we are surprised to find a study of the pancreatic juice omitted, and on the theoretical side no allusion is made to Emil Fischer's work on the ultimate cleavage products of the proteins. Some passages read as though the action of pepsin and trypsin stopped at the albumose and peptone stage. Surely every student nowadays must know something of polypeptides and amino-acids.

The illustrations, as a rule, are clear and judiciously selected, but the diagram of the absorption spectrum of hæmoglobin is very imperfect; indeed, the whole subject of blood spectroscopy is given in the merest outline.

Every teacher has, of course, his own ideas on the relative importance of the different parts of his subject; it is even possible that another reviewer might commend what the present one feels inclined to criticise. Two actual errors are, however, present; one is that fibrin is spoken of as a calcium compound of fibrinogen; the other is found in the description of the Adamkiewicz test for proteins, the colour reaction being described as due to the carbohydrate radical, whereas it has been proved to be due to tryptophan. W. D. H.

River Discharge. By J. C. Hoyt and N. C. Grover. Pp. viii+137. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1907.) Price 2 dollars.

WE have from time to time directed attention to the hydrographic survey that has been in operation for several years by the Geological Department of the United States Government. This survey is for the purpose of ascertaining the water resources of the country available for domestic use, irrigation or power.

The authors of the book now under notice have both been engaged in the survey work, and give in a thoroughly practical and useful way the result of their experience, and of the methods adopted in carrying out the work.

The information both as to the methods and the instruments used should be of great value to engineers engaged in hydrographic work and to students. The text is accompanied by twenty-four illustrations showing the various forms of current meters in use, the method of rating these, the floats used, the cables and cages used for obtaining velocities across wide rivers, weir stations, &c.

The book is divided into six chapters, dealing respectively with rainfall and evaporation; instruments used for obtaining velocities and depths; cable-station equipments; wading stations; theory and practice of measuring discharges; weirs and weir formulas; discussion and use of data; together with seventeen tables for facilitating the computations in various hydraulic problems.

Constructions in Practical Geometry. By the Rev. H. F. Westlake. Pp. viii+50. (London: George Philip and Son, Ltd., 1907.) Price 1s.

A COLLECTION of simple geometrical constructions without proofs, which is said to represent the minimum knowledge of the subject required of candidates in the Oxford and Cambridge School Examinations, is here provided. All the work can be done with a ruler and pair of compasses. The diagrams are clear and the instructions simple. A boy of twelve years of age should have no difficulty in mastering the course of work.

LETTERS TO THE EDITOR.

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

The International Memorial Statue of Lamarck.

THE subscription list for the purpose of erecting a statue of the great French naturalist Lamarck in the Jardin des Plantes, Paris, where he did much of his work, will shortly be closed.

English men of science will, it is hoped, realise that it is now time to send subscriptions in order to show their regard for the memory of the great man whose name stands by the side of that of Darwin as a philosophical naturalist.

Subscriptions of any amount may be sent at once to me at the Natural History Museum, Cromwell Road, S.W.; their receipt will be acknowledged, and the subscriptions sent to the committee of French naturalists who are collecting funds, and will issue a list of subscribers; or subscriptions may be sent direct to Prof. Edmond Perrier, director of the museum, Jardin des Plantes, Paris.

E. RAY LANKESTER.

British Museum (Natural History), Cromwell Road, London, S.W.

Mulattos.

MAY I have a line to correct Sir William Thiselton-Dyer's impression (p. 126) that the tragic story of The Pure White Mother and the Coal-black Babe was accepted by me "as accurate and in perfect good faith"? I suppose I ought to have underlined the gentle sneer at a blackness transcending the natural blackness of a negro baby. At any rate, I told the anecdote simply to illustrate the nonsense people will talk under the influence of race mania, and I hope it will not be added too hastily to the accumulation of evidence on the Mendelian side.

H. G. WELLS.

Nest Eggs of Platypus.

MY attention has been directed to the review of Mr. le Souef's book on "Wild Life in Australia" (NATURE, October 24) and to the reviewer's subsequent note on the eggs of Platypus (NATURE, November 28). The reviewer states that there "appears to be no definite evidence that the eggs" of Platypus "are really laid entire." As I had the good fortune to find some in that condition a few years ago, I think it well to record the fact. I have already shown these eggs in Sydney and to the British Association (1899), the Royal Society of Edinburgh, and other scientific bodies, but, alas! I have not found time to write a full account of my material, and I have been putting off—perhaps too long—in the hope of getting sufficient leisure for the task.

In September, 1897, I visited Gayndah, in Queensland, in search of the eggs of Ceratodus and Platypus. I had at once abundant success as regards the Ceratodus material, and so was tempted to devote most of my time to it. I shot a few specimens of Platypus, however, and did a little digging for eggs, without finding any. I did, nevertheless, have success of a kind with Platypus. On the last day of my fortnight in the district (September 20) I managed to find a nest with an adult female Platypus and a young male 5½ inches in extreme length. The mode of finding was both interesting and instructive. My two men and I, after trying several burrows in vain, came on the productive one. After following it for about 10 feet we reached the "breathing hole"; after another 7 feet we came to an apparent end of the burrow, and were greatly disappointed, as we had seen clearly the wet and inwardly directed footprints of a Platypus all the way from the external opening. One of the men groped about eagerly for any sign that the Platypus was working away from us, and finally we were able to track the burrow—filled though it was—through the hard surrounding soil. It soon appeared that the tube had only been blocked for a short distance by loose soil, which was doubtless of use in keeping out intruders. After a short distance we got beyond the plug, and came again to an open passage. Fully 21 feet from the bank we came upon the nest. It was just large enough to permit of the adult Platypus turning in it. The top was about 9 inches above the bottom, and was about a foot from the surface of the soil. The nest itself was made of bark, leaves, &c. The mother and her offspring were quite buried in the material of the nest.

In 1898 I was again able to spend a few days in Gayndah, and I secured several uterine eggs from Platypus and three entire nest eggs. On August 31 I got two nest eggs adhering together, each of them about 15 mm. in greatest diameter. The eggs were perfectly intact, and the shells firm. The embryos were far advanced, and measured about 1 cm. in length.

On September 11 I got another intact nest egg and a female adult at the end of a burrow. The embryo in this egg was even more advanced than in the others.

I secured about the same time several nest embryos, and I was inclined to think that my visit was rather late in the year for nest eggs.

I may add that, as a rule, in following a productive burrow I had to work through one or several "plugs." It would seem as if the mother Platypus, even when at home, adopts the same method of securing safety as rabbits make use of when leaving their young in a burrow.

Queen's College, Belfast. GREGG WILSON.

Sulphur as an Insulator.

THE gold-leaf electroscope, simple as it is, has proved itself to be an excellent instrument for showing the properties of statical electricity; but usually it has this drawback, namely, that it does not retain an electrical charge at a constant value for a conveniently long period of time. Recently an aluminium-leaf electroscope has been tested by me for insulation; the results, which speak for themselves, may be of interest to others who employ this electrical instrument. The electroscope was designed by Prof. J. S. Townsend, F.R.S. Its excellence depends on the metal leaves being supported by means of sulphur. The appended table shows how it behaved during ten days, on many of which rain fell, and from the air in the room where the experiment was made moisture was freely formed on bottles and metal instruments. Each division indicates a potential difference of 100 volts. The charge was positive; * indicates rain:—

Date	Time	Divisions
*Nov. 26	11 a.m.	8·0
* ,, 27	11 a.m.	7·0
* ,, 28	Noon	5·0
* ,, 28	6 p.m.	5·0
,, 29	11 a.m.	4·75
,, 30	11 a.m.	4·5
,, 30	6 p.m.	4·25
Dec. 1	Noon	4·0
,, 1	6 p.m.	4·0
* ,, 2	Noon	3·5
* ,, 2	6 p.m.	3·5
,, 3	10 a.m	3·0
* ,, 4	11 a.m.	2·75
,, 4	3.30 p.m.	2·5
,, 5	Noon	1·0
,, 6	6 p.m.	0·0

I have also a quadrant electrometer having a long suspension of metal ribbon. All parts of this instrument are supported on pure sulphur; an experience lasting over many years has proved the excellence of sulphur as an insulator. Of course, an instrument so constructed requires careful handling, but when once erected in a suitable niche it will be found to give hardly any trouble and to keep its charge well. It seems somewhat strange that with some few and noteworthy exceptions, sulphur as an insulator should not be more frequently employed in the physical laboratory at the present day, as its excellent qualities were known and utilised in the early days of electrical science before 1797 by Wilcke, Œpinus, Henley, and others. I may add, in conclusion, that in the construction of the interesting little electrical dry pile apparatus, whereby a small bell has been constantly struck for forty-two years in the Clarendon Laboratory, Oxford, sulphur was employed as the insulator.

F. J. JERVIS-SMITH.

NOTES ON ANCIENT BRITISH MONUMENTS.[1]

III.—*Some Measurements in South Wales.*

THANKS to the kindness of the Rev. John Griffith, Col. Morgan and other friends, I was enabled last August to visit several monuments in South Wales.

I had previously inquired of persons living in North Wales about the existence of cromlechs and other memorials of the past in that region, and had been informed that they were very rare; but before my visit to Swansea the Rev. J. Griffith had told me that he personally knew of forty cromlechs in South Wales, so one would suppose that the conditions are very different in different parts of the Principality; but this does not appear to be so, for I have since found that Anglesea is richer in these monuments than Glamorgan. Perhaps the explanation is that there is little *general* interest taken in these matters.

The most important cromlech I visited under the auspices I have mentioned was that of Maen Ketti, or Arthur's Stone, in Gower, whither we motored from Swansea.

FIG. 10.—Arthur's Stone.

The antiquities in this region, which are very numerous and important, and include the remains of one or more avenues as well as the cromlech, were carefully studied by Sir Gardner Wilkinson.[2]

In his most interesting account of them he begins by pointing out the important place the cromlech itself occupies in Welsh tradition :—

"If the Greeks recorded the 'wonders of the world' in their time, under the mystical number seven, four of which might be claimed as their own, the Cymry have also recorded the wonders and mighty labours of the Britons in one of their Triads under their favourite, an equally mystical, number three: namely 1, raising the Maen Cetti; 2, erecting the work of Emrys; and 3, heaping the pile or mound, of Cyfrangon. The first of these is the stone of Cetti, or 'Arthur's Stone'; the second, Stonehenge; and the third, apparently, the mound called Silbury Hill, near Abury."

For Sir Gardner the cromlech was a great tomb, as his description will indicate :—

"The great cromlech, called Arthur's Stone, stands on that part of the hill called Cefn Bryn in Gower, which is an outlying branch projecting from the north side of the main ridge Cefn, or 'backbone'; and the great number of carns in that locality show that it was selected as the most appropriate spot for the burial of the dead in early British times. For though several carns, or tumuli, are found on other parts of the hill, they are more scattered, and evidently occupy positions not so peculiarly chosen for the purpose."

He next refers to the avenue.

"Near to the great cromlech is a line of four, or perhaps five, stones, standing at irregular distances from each other, and in a direction nearly east and west, which has every appearance of being the remains of an avenue. If so it passed a little to the north of the cromlech; and though these stones only form a portion of one side, or of one row of that avenue, some of the corresponding stones may be traced on the other side, and give the avenue a breadth of about 49 feet. The five most conspicuous stones on the north side may be the isolated remains of a great number which once stood there, the intervals between them being respectively 165 feet, 79 feet, 149 feet, and 107 feet; and the whole length of the line, from the most easterly to the westernmost stone, nearly opposite or to the north of a drive or grass road apparently made there in later times, which passes to the north of the cromlech; and as the stone opposite the cromlech (the westernmost of the five above mentioned) is distant from it about 60 feet, this alone suffices to show that the avenue did not run direct to that monument. It is difficult to determine whether a corresponding line of stones formerly stood on the opposite or south side, so as to form a real avenue; but even if this were so, the avenue would not, as we have already seen, lead to, but past, the cromlech, as the grass road does at the present day. It is also difficult to decide whether the road has taken the place of an older one, once the centre of the avenue, or is a drive of entirely recent origin made for the purpose of passing near the cromlech, and round the great carn beyond it to the west; whence it continues over the adjoining part of the hill. It certainly has the usual appearance of old paths, such as we find in the vicinity of ancient ruins, the grass being short and smooth; though this may have been caused by the removal of the fern and furze, and the constant use of the road after it was formed into a drive. It is, however, reasonable to suppose that the few stones, which stand here and there to the south of the grass road, constituted part of the corresponding side of the

[1] Continued from p. 84.

[2] "Avenues and Cairns about Arthur's Stone in Gower," by Gardner Wilkinson ("Arch. Cambrensis," fourth series, vol. i., pp. 23-45).

avenue, though the intervening distance of 49 feet (6 feet more than the width of the eastern avenue at Abury) may appear an unusual breadth for one, the stones of which do not exceed 3 feet to 3½ feet in height. I may also state that other stones appear here and there, on both sides of the grass road, beyond the limits of the portion of the avenue marked by the five stones, which may be a continuation of the same double line to the east and west. They would not, however, be sufficiently conspicuous to suggest the existence of an avenue, if the five stones had not been present to prove it. Many also stand at the extreme end, to the south-east, where the first carns are met with on this part of the hill."

Next follows a statement which shows what a keen and practised observer Sir Gardner was. Had I known of it earlier it would have saved me much trouble.

"I need scarcely observe that it is by no means necessary that the avenue should lead direct to Arthur's Stone, and it is more usual to find a cromlech at one side of, and at a short distance from, it; that near Merivale Bridge, on Dartmoor, stands about 50 feet to the south of the avenue, and the Dolmens in Brittany are, in like manner, placed outside the avenue. A carn also stands about 80 feet south of the same avenue near Merivale Bridge; but about 560 feet west of the cromlech, in the centre of the avenue, is a concentric carn, of which the diameter is about three times the breadth of the avenue. The position of Arthur's Stone with respect to the avenue is, therefore, similar to that of some other cromlechs in this country and in Brittany, but while we see that the avenues of Merivale Bridge, and in some other places on Dartmoor, terminate in an upright stone, a carn, a concentric aisle, or some other sepulchral monument, we are unable to ascertain how the two ends of the Cefn Bryn avenue were closed or to what they led."

The avenue, which was perfectly obvious, lay on our way to the cromlech, so I measured it first. The azimuth (magnetic) to the south-east was S. 136° E., height of horizon 1° 30′. In the north-west direction the elevation of the horizon was 0°.

The cromlech from its state of wreckage was much more difficult to measure. The length of the quoit is roughly north-west and south-east, and the long faces are not parallel, and, indeed, a large mass has been detached, but the north-west side is pretty plane. I measured its direction as N. 82° E., and on examining the supporters as well as one was able, the opening of the cromlech appeared to lie in that direction. I have no note of the height of the horizon, but Mr. Griffith tells me that it is hilly, let us assume 1°.

Now what do these azimuths mean? I can answer this question best by giving the following table, which shows without any possibility of doubt that these Gower monuments, like those in Cornwall, deal with the May-year sunrises, the avenue with the rise in November, and the cromlech with the rise in May.

Gower, lat. 51° 37′ N., variation 18° W. May-year values, theoretical.

Conditions	May		November	
	True	Magnetic	True	Magnetic
Sea horizon: refraction and semi-diameter ...	N. 62° E.	80°	S. 64° 40′ E.	133° 20′
1° hill: refraction and semi-diameter	N. 63° 36′ E.	81° 36′	S. 62° 33′ E.	135° 27′
2° hill: refraction and semi-diameter	N. 65° 10′ E.	83° 10′	S. 60° 58′ E.	137° 2′

To compare theory with the actual magnetic observations we have:—

	Computed value	Measured
Avenue, November sunrise	136° 14′	136°
Cromlech, May sunrise	81° 36′	82°

Need I say that these results of the first measurements made in Wales are very encouraging, and, more than that, *helpful*, because they show that the Cornish experience can be fully utilised, as we are dealing with no new thing.

Another cromlech we visited is one of great interest. I suppose its quoit is the largest in Britain. The north side is entirely closed by a large supporter; the south entirely open along its top; in the east and west ends there are openings. This large rectangular cromlech is situated in the parish of St. Nicholas in Duffryn Golych or Goluch (The Vale of Worship), near Cardiff. It is called by the natives Castell Corrig (Dwarf's Castle), a name which suggests belief in the presence of fairies there.

It seemed at first probable that this monument might have a high south-east alignment. Mr. Griffith noted the openings in the east and west supporters, and found the eastern azimuth of the north supporting slab to be N. 76° E. (true), with a height of horizon of 2°. This particular wall need not necessarily be parallel to the outlook of the cromlech, which for the May sunrise should be, as the previous table shows, N. 65° E. It is too early, therefore, to claim it as oriented, like Arthur's Stone, to that sunrise; we may be dealing with the Pleiades, but to settle matters some excavations and further measures are required, and I am glad to learn that the Cardiff Naturalists' Society has made arrangements with Mr. Cory, on whose estate the cromlech stands, for the necessary excavations in the spring of next year.

A few yards to the west of the large cromlech there are the remains of another not nearly in such a good state of preservation, but one side support is fairly in position, and, as I shall show later on, we are justified of taking this in the absence of more precise information.

The azimuth of this stone towards the E. is S. 51° E.

Evidently, then, we are not dealing with the May-year. Is it a solstitial cromlech? I give, as before, the theoretical azimuths.

Solstice azimuths in lat. 51° 30′ for 2′ of the disc showing above a sea-horizon, refraction being taken into account.

Summer solstice	... ...	N. 48° 42′ E. or W.
Winter ,,	... ...	S. 51° 35′ E. or W.

We see that the azimuth tallies exactly, so we must accept it as a cromlech directed to the winter solstice sunrise.

With regard to another cromlech, St. Lythan's, in the same neighbourhood, known locally as Gwâl y Vilast, "the lair of the greyhound bitch," the azimuth of the north stone, S. 88° E., shows it to have been oriented to the equinoctial sunrises in March and September. The cromlech opens to the east.

On a previous visit Mr. Griffith found outside the cromlech chamber a red sandstone pebble used both as a pounder and a rubber or burnisher. It may have been taken out of the chamber when the latter was uncovered or cleared out. It was right on top of the cairn shell, in which the chamber was once embedded.

I have now referred to all the sun-temples we found in our two days' inquiries. Both Mr. Griffith and

myself made measures of other monuments, but space fails me to refer to them now; still, I must make one exception.

We measured still another cromlech of very considerable interest, as in it we dealt with a presentation to the rise of a clock-star, and no longer to the sun. This is the remaining interior of a four-chambered barrow situated at Parc y Braose, or Parc Cwm, or the Green Combe. It was excavated by Sir John Lubbock, now Lord Avebury. The true azimuth is N. 8° E., the height of the horizon 6°. These data give us Arcturus 2600 B.C., a little earlier than the Cornish monuments with somewhat similar orientations.

It will be very instructive at some future day to compare the plans of the Castell Corrig cromlechs and that of Arthur's Stone with a view of determining the exact alignments of the supporters. I have already done this work on the plans of the Cornish cromlechs.

A study of Lukis's plans, especially of the stones still upright, brings out many interesting points, among them the fact that there were two general methods of building. One was to plant one or two stones in the exact direction of the alignment. The location of the other stones did not matter so long as the quoit was properly supported, but in many cases they were set up parallel to the directing stone, as we may call the first one erected. Another system was to support the quoit on a tripod. When this was done its greatest length was sometimes at right angles to the direction of orientation, this direction being indicated by the alignment of the single stone at one end.

It often struck me in Cornwall that the exact alignments, especially to the May-year sunrises, *which really required a knowledge of the number of days which had elapsed since the last solstice*, were the work, not of each local druid, but of peripatetic astronomer-priests who went from place to place establishing and orienting the circle and the priests' house (cromlech), and then leaving subordinate priest-druids —curates—in charge, who could not go far wrong when the alignment of both circle and cromlech fixed the May, August, November and February festivals; the solstices they could easily fix for themselves, because then the sun rose in the same place on three successive mornings.

The study of Lukis's plans shows that the work of the peripatetic priest might really have been limited in the first instance to the setting up of the single directing stone. Of course he would examine the finished work in his tours of inspection, probably at the critical times of the year—the quarter days.

I sent this suggestion some little time ago to the Rev. J. Griffith, who has greatly helped me by permitting me to draw upon his vast store of Welsh tradition. His reply really supplies us with a new line of evidence as to the tenancy of cromlechs by living men, in addition to those I have already put forward.

"I have spotted your travelling time-keeper, though I seem never to see anything until you point out what to look for. He is very conspicuous in Welsh cave legends. There is the lonely watchman—your 'curate'—waiting and waiting for him. All over the country a couplet is known as having been uttered by the 'curate.'

'Long the day and long the night,
And long it is to wait for Aaron.'

"Sometimes his name is Noah. It is clear why the pagan should have a Bible name; Aaron is the rationalised form of the name of a Welsh legendary hero—Arawn.

"In two cave legends the curate is heard exclaiming:—

'The hour is come, but the man is not.'

In one case it is the eve of New Year's Day.

"Who could the mysterious man be if not your peripatetic astronomer-priest? He was evidently very much wanted for the great festival. Your surmise or conclusion has lit up a round dozen tales I now remember, and doubtless I can find many more."

NORMAN LOCKYER.

THE INCREASED ENDOWMENT OF UNIVERSITIES.

WE are glad to see that the Press is again directing attention to the importance of an increased endowment of our universities, not so much, at the present moment, of the older universities as the younger ones. It is, in fact, the Government action in regard to Manchester University which has directed attention to the subject. That opinion is getting more enlightened is evidenced by the fact that it is now beginning to be recognised that the real gainer by such endowment as this is not any particular locality or university, but every student throughout the length and breadth of the land who is debarred by high fees from attending university courses, the university being compelled to charge high fees in order to go on at all in consequence of the absence of adequate income from any other source.

Here are some extracts from a recent article in the *Morning Post*, to take one instance:—

"It is necessary if the nation is to continue to be an independent Power to have a Navy able to defeat and destroy its rivals, and an Army able to do all such fighting, in case of war, as the Navy cannot do. But this necessity, of which no one is enamoured, does not absolve the Government from the duty of doing the very best it can for the training not only of the rank and file, but of the leaders of its population. Mr. Asquith will provide in his estimates some fifty million pounds for the needs of the Navy and of the Army. This of course cannot be reduced. For the modern universities and colleges that represent a great popular effort towards providing a better training for leaders than existed for the fathers of men now at work, and for many of those men themselves, Mr. Asquith cannot imagine that he ought to provide more than 100,000*l*. But this sum might be increased without reducing the other. The fifty millions are unproductive expenditure. They are mere insurance, a disagreeable necessity. But the money spent on educating young people is the most remunerative outlay possible to a nation.

"The University of Manchester is the means, in most cases the only means, open to the inhabitants of a great area in South-east Lancashire, Cheshire, and part of Yorkshire, a population numbered by millions, of obtaining an education going beyond school work. It is admittedly among the best of modern universities, with a large staff of first-rate professors, an admirable set of buildings, and an assiduous, devoted, and capable governing body. It represents the chance of South-east Lancashire providing itself with leaders in industry, commerce, the sciences, and the humanities.

"Manchester may have to compete with some place like Berlin, the centre of a comparatively small population. Berlin does not limit its Government grant to university and other forms of higher education to such a sum as ten thousand a year, therefore, and Berlin tends to eclipse Manchester in the fields of industry, trade, science, art, and the humanities.

"Mr. Asquith knows as well as anyone else how many millions such men as Sir Robert Giffen and Sir Norman Lockyer think the British Government will have to spend on universities and colleges if England is to keep her place among the nations. They may talk, but he draws the

line at one hundred thousand pounds. But does he not see that the welfare of England and her people depends above all things on their personal character and qualities twenty years hence, on the kind of men and women that she is turning year by year into citizens and mothers?"

Mr. Asquith we suspect knows more of these matters than the writer in the *Morning Post* thinks. The Chancellor of the Exchequer, in speaking at the London Chamber of Commerce in November of last year [1] said:—

"The strain of foreign competition presses upon us in every walk of business and every market in the world, and, whatever are the contributory causes of the pressure which we all in a greater or less degree experience, there is not a man acquainted with the facts who will not agree that in the case, at any rate, of some of our most formidable competitors—for instance, Germany and the United States—one of the great sources from which they have derived exceptional strength in their commercial and industrial struggle with us has been the superior development of their technical and educational system."

But it may, after all, be that Mr. Asquith is unacquainted with the methods adopted by the German Government, to take one instance, to secure this superior development. German universities are considered by our statesmen as a *quantité negligeable*; all their attention is directed to the German ironclads. This is not so in Germany, as witness the increased endowment in fifteen years of some German universities taken at random:—

State Funds.

	1891–2 £	1906 £
Berlin	107,057	161,539
Bonn	45,806	59,192
Breslau...	44,749	66,375
Göttingen	20,877	35,303
Greifswald	13,974	28,889
Halle	33,284	59,819
Kiel	28,188	53,072
Königsberg	39,930	57,344

The same growth of enthusiasm for higher education which is characteristic of German statesmanship is met with throughout the more densely populated eastern United States. When a comparison is instituted between the income of universities and colleges in the States in the year 1899–1900 and the income in 1904–5 (the latest year for which detailed official statistics have been published), that is fifteen years later, an enormous increase is found to have taken place. In the earlier year the total income of these institutions of higher instruction was 2,399,000*l.*, while in 1904–5 the amount had grown to 7,110,000*l.* But large though these sums are, they take no account of the generous benefactions of American men of wealth referred to later. From this source the universities and colleges received in 1899–1900 2,399,000*l.*, while fifteen years later the amount given for the spread and development of higher learning reached the magnificent sum of 3,335,800*l.* Harvard University alone received during the later year 466,000*l.*, Yale benefited to the extent of 279,000*l.*, and Columbia was enriched by 236,000*l.* Figures such as these serve better than any words to exhibit the comparative insignificance of the 122,000*l.* which, as we shall show, represents the total State endowments of English universities.

But British statesmen cannot be held responsible for the unpopularity of universities and colleges as the object in this country of the bequests and gifts of wealthy men and women. In the following table, therefore, benefactions are excluded, and the growth in the income of the universities of five important eastern States in America is given, as typical of the advance made in the eastern half of the United States in the provision for higher instruction during the fifteen years under consideration.

Total Income, Excluding Benefactions.

	1899–1900 £	1904–1905 £
Massachusetts ...	521,800	614,000
New York	705,700	981,300
Pennsylvania	390,100	534,400
Ohio	266,600	387,000
Illinois...	388,800	585,800

The decision of Mr. Asquith to reduce the grant of Manchester University from 12,000*l.* to 10,000*l.* a year, we presume, is based on the stern argument that as little money as possible should be spent on the higher education; even although it is the true source of national development; it is a question, not of national, but of party politics.

In the case of party politics, of course, economy may be thrown to the winds. Mr. Haldane, when he opened the new college at Reading,[1] told us:—"The present Government proposes to spend an extra 1,000,000*l.* a year on elementary instruction, and the late Ministry spent more than that sum additionally for the same purpose, *but these payments arose out of controversies which had* LITTLE TO DO WITH EDUCATION."

Dealing with the modest contribution of the British Government to the universities and colleges of England, the estimates show us that in 1903 the endowment of universities amounted to 14,800*l.*, which we find increased in 1907 to 22,000*l.* In 1903 the grant to English colleges stood at 26,000*l.* This has now been increased to 100,000*l.*, we believe in consequence of the strong representation made by the British Association deputation in 1904. It is seen that at present the total State endowment of the English universities—22,000*l* + 100,000*l.* = 122,000*l.*—is some 40,000*l.* short of the German State endowment of one university alone, that of Berlin.

We are told that to provide the "superior development of our technical and educational system," which even Mr. Asquith acknowledges is necessary to meet "the commercial and industrial struggle," we must trust to private endowment. Cambridge has recently asked for a private endowment to provide funds which the university wants at once. At the rate at which this private endowment has been coming in during the last few years, ninety years will elapse before all these funds are in hand. This is a fair sample of what private endowment does for university education in England, while the competing universities and colleges of the United States last year received nearly 5,000,000*l.* from this source,[2] every penny of which tended to reduce fees and extend the benefits of university instruction to a greater number of students, the peace army of a nation.

In addition to this it is important to remember that American experience all goes to show that the best results are obtained when universities are chiefly dependent on the State and not upon private generosity. It has been pointed out recently in the United States (NATURE, vol. lxxvii., p. 93) that as a result of the gifts of millions of dollars from great American financiers, the universities are in danger of being reckoned the purchased servants of a narrow caste. It is being urged there, as we have urged here, that it is the duty of the State to provide higher education for the people; and there is every indication that American authorities may be trusted to maintain the efficiency of their universities and colleges.

The increase in the efficiency of colleges and universi-

[1] NATURE, December 6, 1906 (vol. lxxv., p. 141).

[1] NATURE, November 1, 1906 (vol. lxxv., p. 22).
[2] *Ibid.*, January 3, 1907 (vol. lxxv., p 137).

ties in this country is too pressing a need to be dependent upon party politics. Unless our statesmen can be made to realise the supreme importance of this matter and be persuaded to deal with it in a patriotic manner, generously and expeditiously, as if there were no votes to retain or secure, we must reconcile ourselves to the idea that as a manufacturing and distributing people we shall in due course have to occupy a third or fourth place among the nations of the world. In Germany, the United States, and now in Japan rulers have learnt the lesson that efficient education and industrial success are related to each other as cause and effect; and, moreover, they appear to be supported by an enlightened public opinion.

If our statesmen refuse to lead, we must make every effort to educate the voters of the country to realise the certain results of a policy of drift from which the most important of our national questions—so far as the future welfare of the British Empire is concerned—is suffering. If, meanwhile, our present supremacy is lost, it will not be because men of science have failed to warn their countrymen of the scientific spirit and energy which are yearly increasing the industrial efficiency of our great competitors.

NOTES.

On the day of going to press we learn of the death of Lord Kelvin, an announcement which will be received with deep sorrow throughout the civilised world. To men of science, Lord Kelvin's achievements in the realm of scientific thought and discovery have long been familiar; and thirty-one years ago, in NATURE of September 7, 1876 (vol. xiv.), his remarkable contributions to natural knowledge were described in our Scientific Worthies series, of which he was then the subject. His death is a loss to science which only scientific workers can adequately realise. The world has to deplore the departure of a brilliant and inspiring figure; while science mourns that a leader whose influence has stimulated progress in many directions during a remarkable period has passed into stillness. For the body of one who has brought such honour to the British nation, the only appropriate place of burial is Westminster Abbey. We trust that steps will be taken at once to secure this mark of national recognition of the greatness of one who has long been regarded as the most distinguished man of science of modern times.

A life of Lord Kelvin has been in preparation for some months by Prof. Silvanus Thompson, who was entrusted with this work, and to whom Lord Kelvin himself furnished numerous biographical details and other matter for the purpose. It will be published in the course of next year by Messrs. Macmillan and Co., Ltd.

The Prince of Wales was elected an honorary member of the Royal Irish Academy at the last meeting of the academy. In the case of the election of a member of the Royal Family the election is by resolution, which was moved by the Earl of Aberdeen, Lord Lieutenant, who is the visitor of the academy, and seconded by Mr. D. H. Madden, Vice-Chancellor of the University of Dublin.

Sir Norman Lockyer, K.C.B., F.R.S., has been unanimously elected president and an honorary member of the Penzance Natural History and Antiquarian Society in recognition of his services to the study of the circles and other prehistoric remains in west Cornwall.

M. Edouard Cuyer has been elected president of the French Anthropological Society for 1908.

Two lectures suitable for a juvenile audience will be delivered for the Society of Arts on January 1 and 8, 1908, at 5 p.m., by Mr. F. Martin Duncan, on "The Scientific Applications of the Kinematograph."

A course of six lectures on the geographical distribution of rainfall in the British Isles will be given by Dr. H. R. Mill in the map room of the Royal Geographical Society on Thursday evenings in January and February, 1908, beginning January 23 at 5.30 p.m.

Prof. R. W. Wood, professor of experimental physics in the Johns Hopkins University, has been awarded, *Science* states, the John Scott legacy premium and medal of the Franklin Institute of Philadelphia for his discoveries in colour photography.

The Russian Physico-chemical Society has arranged to hold a conference of general and applied chemistry in honour of Mendeléeff at the beginning of January, 1908, at the University of St. Petersburg. Several discourses will be delivered on the great chemist's life and works. We learn also from the *Revue scientifique* that the journal *Russj* has inaugurated a subscription for the purchase of a Mendeléeff House, which, like the Hofmann House in Berlin, would be used for the meetings of learned societies.

The eleventh International Congress of Navigation will be held at St. Petersburg from May 31 to June 7, 1908, under the patronage of the Emperor of Russia. The previous meetings were held at Brussels, in 1885; Vienna, 1886; Frankfort-on-the-Main, 1888; Paris, 1889; Manchester, 1890; London, 1891; Paris, 1892; the Hague, 1894; Brussels, 1898; Paris, 1900; Dusseldorf, 1902; Milan, 1905. Arrangements have been made for communications and discussions on several questions relating to inland and maritime waterways, including the industrial and agricultural utilisation of rivers, and for scientific excursions and inspections of some of the rivers, canals, and sea ports in Russia. The address of the general secretary of the congress is 7 Ismailovsky Prospect, St. Petersburg.

The current number of the *Revue Scientifique* contains an account of "La Caisse des Recherches scientifiques." The fund was founded by law on July 14, 1901, on the proposition of M. Audiffred, with the double object of assisting medical science in its researches and of providing financial assistance to original workers in pure science. The fund receives from the French Government an annuity of 5000*l*., and at its inauguration M. Audiffred gave 2400*l*. The idea of the fund has not proved altogether popular, for in 1906 the Caisse des Recherches received general donations to the extent only of just under 200*l*. But there has been considerable improvement this year, and it is anticipated that the amount will be much larger; the Paris Municipal Council itself gave 200*l*., and several general councils have given small sums. Since its creation the Caisse has distributed more than 24,100*l*., of which about 1000*l*. only was available for work in other than medical and biological science. M. Rigaut may well say that these sums are wholly inadequate so far as the needs of science are concerned.

Prof. Asaph Hall, whose death we announced last week, will always be remembered as the discoverer of the satellites of Mars, since the sensational character of the discovery appealed powerfully to the public mind; but in many ways he accomplished much useful work in every department of astronomy, and exhibited an industry which placed him in the forefront of American astronomers.

Diligence and energy were his principal characteristics from the time when he entered Harvard Observatory, as a junior, fifty years ago, until he retired from the honoured position of professor of astronomy in 1901. The greater part of his work, however, was accomplished at Washington, and it is difficult to say what department of astronomy he did not enrich. He was one of the earliest to appreciate the value of the observations of Mars as a means for deriving the solar parallax, and he took part in solar eclipse expeditions for physical work on the sun. His observations of planets, whether for position or for surface detail, were frequent and accurate. He was an industrious observer of double stars, and his work on stellar parallax, as well as in the determination of the relative positions of stars in clusters, is well known. On the theoretical side of astronomy he contributed papers on the secular perturbations of the planets, the computation of orbits, and many similar problems. As a geodetist, the value of his work in the determination of longitudes and on the employment of the occultation method has long been recognised. His career was that of a typical practical astronomer, and the recognition of his work was shown by his election into many learned societies. He was both gold medallist and foreign associate of the Royal Astronomical Society.

THE subject of river pollution from the naturalists' point of view was introduced by Prof. R. Meldola, F.R.S., at a largely attended conference meeting, convened under the auspices of the Essex Field Club, and held in the Municipal Technical Institute, Stratford, on Saturday, December 14. The Mayor of West Ham was in the chair at the beginning, and subsequently the president of the Essex Field Club (Mr. Miller Christy). Among other speakers upon the subject were Mr. E. B. Barnard, M.P. (chairman, works committee, London Water Board), Mr. David Howard, J.P. (past-president Society of Chemical Industry), Dr. Parsons (Local Government Board), Sir Alexander Pedler, K.C.I.E., F.R.S. (hon. secretary, British Science Guild), Sir William Ramsay, K.C.B., F.R.S. (president Chemical Society, and chairman Royal Commission on Sewage Disposal), Dr. Sanders (medical officer of health, county borough of West Ham), Dr. Sommerville (lecturer on public health, King's College, London), and Dr. J. C. Thresh (medical officer of health, Essex County Council). At the close of the meeting the following resolution was moved by Sir Alexander Pedler, seconded by Mr. E. B. Barnard, carried unanimously, and ordered to be transmitted to the Local Government Board and the British Science Guild:—"That this meeting, having heard the expert testimony of many qualified speakers interested in the improvement of the state of our rivers, streams, and water-ways, it is of opinion that legislative action is urgently needed, and would regard with satisfaction the creation of a central authority under Government for dealing with the general question of water supply throughout the kingdom, as well as with the disposal of sewage and of effluents from factories; such central authority to be given power to apportion expenditure on sewage treatment or other necessary work of purification amongst the communities deriving benefit from such expenditure."

British Birds for November contains an excellent portrait of the late Mr. Howard Saunders to illustrate an obituary notice by Mr. Abel Chapman. The portrait is also published separately by Messrs. Witherby and Co., price 1*s.* 6*d.* The other contents include a paper by Dr. E. Hartert on races of birds peculiar to the British Islands, and a note by Mr. N. F. Ticehurst on the capture in Romney Marsh of a specimen of the American sandpiper, *Ereunetes pusillus*, this being apparently the first record of the species in Europe.

To the *Times* of December 14 Sir T. Digby Pigott communicates an account of a luminous bird—believed to be an owl—recently seen at night in Norfolk. The idea that the "powder-down" patches of certain birds are luminous has been held, we believe, in America, but is generally discredited by ornithologists. The circumstantial account of the Norfolk bird may, however, lead to a reconsideration of the evidence, although we cannot admit that the name *Strix flammea* has anything to do with the alleged phenomenon, as it almost certainly refers to the colour of the feathers of the back. The story that the heron emits a phosphorescent light in order to attract fish also seems "shaky," seeing that the bird is diurnal in habits.

AT the close of a paper published in the November issue of the *Quarterly Journal of Microscopical Science* on the muscles of the head in birds (as exemplified by the domesticated fowl) and reptiles, Prof. H. F. Edgeworth attempts to formulate the leading anatomical features of the common ancestor of those two groups. The list is too long and too technical to be quoted here, but it may be noticed that in certain respects the author finds that birds have more in common with chelonians than with any other group of reptiles. "These features of resemblance suggest at first sight a very distant chelonian relationship for birds, but are in reality very ancestral traits, which are also present in embryonic stages of other sauropsidan groups. The secondary fixation of the pterygo-quadrate and atrophy of the elevator of the pterygoid process, which occur in Chelonia, are strongly marked differences from birds."

IN connection with the preceding note, reference may be made to a paper by Dr. W. Sippel on the structure of the roof of the mouth in birds and mammals, published in vol. xxxvii., parts ii. and iii., of *Gegenbaur's Morphologisches Jahrbuch*. The greater portion of the paper is devoted to the soft-parts of the palate, and it is shown at the conclusion that in homologising the constituent elements of this region in birds and reptiles several misidentifications have been made by previous workers. The long, posteriorly widened median slit in the palate of the bird does not, for instance, represent the secondary choanæ, but rather the orbito-subchoanal cleft. The paper concludes with a comparison of the bones of the palate in reptiles, birds, and mammals, as illustrated by the monitor, the duck, and the dog, and here, too, some important differences distinguishing this region in the three classes are indicated.

IN the December number of the *Popular Science Monthly* Prof. Bashford Dean gives his impressions of the chief museums of Asia, as gathered during a recent eastern tour. Among the institutions referred to is the Raffles Museum and Library at Singapore, of which the author writes in terms of high commendation, the Colombo City Museum, the Madras Museum, and the Indian Museum, Calcutta. Dr. Willey's arrangement of groups of animals to give an adequate idea of the wild life of Ceylon is regarded as one of the great features of the Colombo Museum, while, under Mr. E. Thurston's administration, the institution at Madras is described as one of the most successful of its kind in India. The Calcutta establishment must, however, stand at the head

of all the museums of Asia, its success, in the author's opinion, being very largely due to the policy of selecting as directors men eminent, not only in science, but in administrative ability. Reference may also be made to an interesting article in the same issue on the origin of slavery among ants, by Dr. W. M. Wheeler.

THE training of foresters for India and the organisation of the scientific work of the department form the subject of a leading article in the *Indian Forester* (September), in which the writer points out the necessity for a systematised programme arranging for the compilation of forestry data and research. An article on improvement fellings is concerned with the problem of increasing the growing stock of teak. Premising that many saplings are killed by creepers and faster growing trees, the author, Mr. H. C. Walker, adduces arguments and statistics in favour of taking measures for saving young teak trees by a judicious system of thinning.

AMONG the experimental work referred to by Mr. W. Fawcett, director of the Public Gardens and Plantations, Jamaica, in his annual report for the year 1906–7, the raising of selected seedling sugar canes and the cultivation of Havana and Sumatra tobacco are of primary importance. It is recorded that as a result of comparative experiments a better yield of coffee has been obtained at the Hope Gardens under shade than without shade, and preference is given to the guango, *Pithecolobium saman*. The satisfactory results attending the instruction of small landholders by travelling instructors are noteworthy; by this means, as also by the establishment of agricultural banks and prize-holding schemes, the agricultural population is developing an appreciation for improved methods of cultivation.

MUCH valuable information on insect pests attacking crops is being disseminated by the Bureau of Entomology, forming part of the United States Department of Agriculture. In Bulletin No. 68, part iii., Mr. A. L. Quaintance deals with the trumpet leaf-miner of the apple, *Tischeria malifoliella*, a Tineid moth that is destructive to species of Cratægus and Pyrus. The mines are burrowed by the larvæ in the palisade layers of the leaf. Spraying with kerosene emulsion is recommended for destroying the larvæ and pupæ. Mr. A. A. Girault describes the life-history of the lesser peach-borer in Bulletin No. 68, part iv. The species, formerly referred to Sesia, a genus of moths of the family Sphingidæ, now receives the name of *Synanthedon pictipes*. It occurs principally on plum and peach trees, and must be distinguished from the better-known peach-borer, *Sanninoidea exitiosa*.

IN his annual address to the Australasian Association for the Advancement of Science, Dr. A. W. Howitt gives an account of his reminiscences of Central Australian exploration, and in particular of the search for the ill-fated members of the Burke-Wills expedition. The causes of the failure of this enterprise lay, he shows, in the extravagant amount of supplies provided, for which carriage was inadequate, in the impetuosity of the leader, and in want of cooperation on the part of certain members of his staff.

THE second number of the Journal of the revived Gypsy Lore Society, with its headquarters at 6 Hope Place, Liverpool, contains a reprint, revised by the author, Mr. C. G. Leland, of an article on the remarkable dialect known as Shelta, spoken by wandering tinkers, and apparently of Celtic origin. This a preliminary to a further study of this dialect. Mr. J. Sampson gives an interesting account of his experiences with a gang of German Gypsies at Blackpool. Mr. D. MacRitchie has collected much curious information to prove that throughout eastern Europe the Gypsies were formerly subjects of certain great noblemen, not of Gypsy race, who were appointed to that position by the rulers of those countries. Mr. W. M. Gallichan furnishes a report on the Gypsies of Andalusia, Mr. B. Gilliat-Smith on those of the Rhine Province, and Dr. T. R. Gyorjevic on those of Bosnia. A collection of interesting miscellaneous notes completes an excellent number, which has as its frontispiece a portrait of that eminent Gypsy scholar, Dr. A. G. Paspati.

THE *Reliquary*, under the editorship of Dr. J. C. Cox, in succession to the late Mr. J. Romilly Allen, continues to be one of the most scholarly of our archæological publications. In the last quarterly number, issued in October, one of the most interesting articles is that by Mr. G. Le Blanc Smith on some dragonesque forms on, and beneath, fonts. Numerous examples of such a form of decoration are found in Sweden, but some in this country are equally interesting. One favourite type is that of the salamander, which is always represented as a lizard with bifurcated tail, in which there is one coil or twist. It has two legs set very far back on its body, a rather humped back covered by a pair of wings, longish ears, and a dragon-like head. In many cases the body of the animal is covered with scales, and the wings are clothed with feathers. The toes or claws are invariably three in number. Its countenance bears a look of loathing or disappointment, the symbol of its defeat as representing the powers of evil by the baptismal rite. The best examples of such figures are found on fonts at Norton and Youlgreave, both in Derbyshire. The second type represents dragons or grotesque monsters, humbled and abased, grovelling under the font itself, of which they form the base. Such are the fonts at Hereford Cathedral and at Castle Froome, in Herefordshire. A curious development is that at Ashford, where the animal is carved as though it actually protruded through the shaft of the font—the head at one side, the curly tail at the other. Mr. Le Blanc Smith asks for aid in discovering similar representations of monsters in other parts of the country.

A PAPER on the predetermination of train-resistance was read by Mr. C. A. Carus-Wilson before the Institution of Civil Engineers on December 10. Among the practical conclusions arrived at are that the resistance of the air with a train of bogie-coaches, running at sixty miles per hour, amounts to about one-half the total tractive effort required to haul the train. Experiments conducted by the St. Louis Electric Railway Test Commission show that a large reduction can be made in the front and rear air-resistance by shaping the ends, and that by this means a saving can be effected of 10 per cent. of the total tractive effort with a long passenger train, and 30 per cent. with a single coach.

A COLONIAL OFFICE report (Cd. 3794) has been issued giving Major E. H. Hill's report on the Survey Department of British East Africa. The work at present in progress is the main triangulation of the country. Major Hill says that an additional section of two officers and six or eight surveyors is imperative to prepare topographic maps before the trigonometrical beacons are destroyed. He recommends that topographic maps should be issued on the scale of 1 to 125,000. He discusses a proposal for a school to train African natives for the survey work; but

he regards the natives of British East Africa as at present quite useless for this purpose, while those trained on the west coast could not be employed in the highlands of East Africa. Indian natives are being employed, but have not proved altogether satisfactory.

REVIEWING the world's tin-mining industry, Mr. A. Selwyn-Brown, in the *Engineering Magazine* (vol. xxxiv., No. 2), shows that the world's production of tin last year was 96,196 tons. The active tin-mining fields are few in number, and, as a rule, not in a very prosperous condition, notwithstanding the high value of tin and the large existing demand for it. The alluvial deposits in the Dutch East Indies and in the Malay States are approaching exhaustion, and difficulties are being caused by the scarcity of coolie labour. Bolivia is advancing its consumption, but it is upon Australia and Tasmania that consumers will have to depend for the principal part of their tin supplies, unless Africa should develop into a tin-mining country of importance.

A STRONG gale traversed Scotland and the north-east of England during Friday night and Saturday in last week. During its progress over our island the cyclonic system increased greatly in depth, the lowest reading of the barometer reported being 28·39 inches, at Spurn Head, at 8 a.m. on Saturday. The greatest strength of the wind was from the north-west, and was due to a sharp rise of the barometer in the rear of the disturbance. The heaviest part of the storm occurred over the southern portion of the kingdom, where considerable damage was occasioned, and wrecks, accompanied with loss of life, occurred in the English Channel. Heavy rain preceded the storm, and large tracts of land were flooded in the Midlands and in the southern districts. A fall of temperature was experienced after the passage of the storm area, and frost has occurred in several places.

IN a lecture delivered before the meeting of German Naturalists and Physicians at Dresden in September last, Dr. E. Herrmann directed attention to his researches on the periodical variations of atmospheric pressure, and to the possibility of submitting the phenomena to numerical investigation. For this purpose he used the well-known daily synoptic weather charts of the North Atlantic Ocean and adjacent continents issued by the Deutsche Seewarte and the Danish Meteorological Institute. The diagrams which accompany his paper, a copy of which he has sent to us, seem to show that a succession of analogous phenomena occurs at regular intervals, and that areas of low and high barometric pressure follow each other at certain distances. He asserts that the periods exhibited are due to the moon's movements or to a combination of these with that of the sun. We remember that Sir J. Herschel stated that the moon's influence is "utterly insignificant as a meteorological cause." Nevertheless, Dr. Herrmann's paper may be considered as a painstaking endeavour to throw light upon the intricate processes involved in the general atmospheric circulation.

MR. GUSTAV FISCHER, of Jena, has just published the second edition of Prof. L. Jost's "Vorlesungen über Pflanzen-physiologie," the first edition of which was very favourably reviewed in NATURE of July 14, 1904 (vol. lxx., p. 242). The work has been translated into English, and a review of this edition appeared in NATURE of December 5 (p. 97).

A THIRD edition of "Practical Forestry and its Bearing on the Improvement of Estates," by Prof. Charles E. Curtis, has been published by Messrs. Crosby Lockwood and Son. The work has been revised and also enlarged by the addition of an appendix on the planting of waste lands, a project which the author hopes may not only add to the wealth of the nation, but give employment to the rural population, and so keep them upon the land. It is pointed out in the volume that the management of our woodlands is improving, and that what was once a source of loss is becoming a source of profit.

THE twenty-third issue of "Hazell's Annual," that for 1908, is even more complete than previous editions. It is an alphabetically arranged, cyclopædic record of men and affairs designed especially to be of use in 1908. Articles are provided, for example, on the Olympic games, the Franco-British Exhibition, and on recent work in colour photography. The most important of the Blue-books published during 1907 are summarised, and among these abridgments likely to be of special assistance to readers of NATURE may be mentioned those dealing with agriculture, education, and sea fisheries. The busy worker in many departments of knowledge will find the annual a trustworthy and useful work of reference.

THOUGH it has not increased in price, "Who's Who" continues to grow in size. Messrs. A. and C. Black, the publishers of this work of reference, which may justly be described as indispensable, have this year added eighty-three pages of biographies, and the new volume contains 2040 pages. The biographical notices vary much in length, and, unfortunately, the longest notices are not always those of the most important persons; but, despite such inequalities, the book may be unreservedly recommended to those readers whose necessity it is to know something about the men and women who, for one cause or another, have become prominent in work or play. "Who's Who Year-book, 1908," is also larger than its predecessors, and its clearly arranged and exhaustive tabular matter will continue to be consulted by everybody desiring a minimum of trouble in the task of reference.

THE Rev. Robert Harley, F.R.S., has written an interesting biographical sketch of Robert Rawson, who achieved some distinction in the scientific world by his work in mathematics and on the dynamical stability of floating bodies. Rawson was originally a Midland miner whose mathematical ability attracted the notice of Stephenson and Prof. Eaton Hodgkinson. He became a teacher of mathematics at Manchester, and contributed several papers to the Literary and Philosophical Society of that city. In 1847 he was appointed the first headmaster of H.M. Dockyard School, Portsmouth, upon the recommendation of Prof. Hodgkinson, and he occupied this post for twenty-eight years, among the men who passed through the school during this period being Sir Philip Watts, K.C.B., F.R.S., Sir John Durston, K.C.B., and Dr. Francis Elgar, F.R.S. Rawson died in March, 1906, and was buried in Havant cemetery. Mr. Harley's appreciative account of his career is published by Messrs. J. Clarke and Co., 13 and 14 Fleet Street, E.C., and Messrs. Griffin and Co., Portsea.

IN the "Day by Day" Tellurian which Messrs. G. Philip and Son have submitted to us, a simple and novel means is used to preserve the constant direction of the terrestrial axis in the course of the revolution of the earth around the sun. The tellurian is intended to be suspended on a wall or some other convenient vertical plane. The sun and earth are represented by two globes connected by a rod upon a diagram showing the months and other divisions of the year. As the terrestrial globe is moved around the globe representing the sun, a heavy bob attached by thick wire to the axis is maintained vertical by the

attraction of gravity, and this constant direction enables the axis to be kept inclined at the same angle to the plane of the diagram throughout a revolution. The result is that the terrestrial globe only rotates on its axis once during a complete revolution. This is misleading, and it will be necessary for the teacher to explain that though the device illustrates the different aspects of the earth presented to the sun during the year on account of the constant inclination of the axis, it does not represent accurately the relation between the day and the year. With this reservation, the model may be found of service in teaching astronomical geography.

MESSRS. TAYLOR AND FRANCIS have now published the first part of the fourth volume on Rhynchota, by Mr. W. L. Distant, of "The Fauna of British India, including Ceylon and Burma." These volumes are published under the authority of the Secretary of State for India in Council, and edited by Lieut.-Colonel C. T. Bingham. The third volume on Rhynchota was reviewed in NATURE of July 5, 1906 (vol. lxxiv., p. 221). The present fasciculus gives an account of the homopterus families Membracidæ and Cercopidæ, and four subfamilies of the Jassidæ. The second part—in the appearance of which there is likely to be some delay owing to the necessity of examining material at present contained only in certain Continental museums—will contain the remaining subfamilies of the Jassidæ and an appendix to the whole work.

MESSRS. J. AND A. CHURCHILL have published a tenth edition of Valentin's widely known "Practical Chemistry." Prof. W. R. Hodgkinson has added to the present issue easy experimental work in the early chapters, on the composition of air and water, some carbon compounds, sulphur and sulphuric acid, exercises on quantitative analysis, volumetric analyses, and methods of ascertaining molecular weight. The microscopic structure of some common alloys has been illustrated by photographs, and the whole work revised and brought up to date. The volume now runs to 476 pages, and its price is 10*s*. net.

OUR ASTRONOMICAL COLUMN.

THE MAXIMUM OF MIRA, 1906.—Mr. Naozo Ichinohe, of the Yerkes Observatory, observed Mira, for magnitude, from October 10, 1906, to March 8, 1907, and publishes his results, with a curve, in No. 4219 of the *Astronomische Nachrichten* (p. 311, December 5). These show that the maximum brightness occurred on December 12, 1906, which was about seven days before the predicted date. This early date is confirmed by the results of other observers, which give December 13, 12, and 7 respectively.

A FURTHER OBSERVATION OF COMET 1907*a*.—A telegram to the Kiel Centralstelle from Prof. Wolf states that comet 1907*a* was re-observed at the Königstühl Observatory on December 4. At 11h. 3·3m. on that date its position was $\alpha = 3h.\ 23m.\ 40s.$, $\delta = +50°\ 35'$, a little to the north-east of α Persei, and its magnitude was 12·5. The motion of the object was found to be in accordance with the ephemeris (*Astronomische Nachrichten*, No. 4219, p. 315, December 5).

SPECTROSCOPIC DETERMINATION OF THE ROTATION OF THE SUN.—In a paper published in No. 4, vol. xxvi., of the *Astrophysical Journal* (p. 203, November), Prof. Adams describes at some length the instruments and methods employed by him at the Solar Observatory, Mount Wilson, in a spectroscopic determination of solar rotation period, and, after discussing them, he compares his results with those obtained previously by Dunér and Halm.

In the lower latitudes of the solar disc the recent results agree very well with the values obtained by Dunér and Halm, but in higher latitudes they lie between those of the previous observers. The rate of change of the velocity with the latitude attains a maximum in latitude 30°, becoming less in higher latitudes, and almost disappearing beyond 70°. Twenty lines, lying between λ 4190 and λ 4300, and attributed to different elements, were employed in the research, and it was found that different lines gave different rotational velocities. The titanium line at λ 4290·38 gave a systematically low value, although it is an enhanced line, and might therefore be expected to have its origin in the higher levels of the solar atmosphere. Two lines of manganese, λ 4257·82 and λ 4266·08, gave a consistently high value. Two carbon lines and a line due to lanthanum give low values, thus agreeing with the conclusion that these two elements reside in the lower layers of the sun's atmosphere. There are no indications of a variable velocity for any one latitude during the fourteen months of observation (May, 1906, to June, 1907), and the results appear to show that the photographic method displays a considerable gain of accuracy over the visual method so far as accidental errors of measurement are concerned.

NEWLY DISCOVERED SPECTROSCOPIC BINARIES.—Bulletin No. 123 of the Lick Observatory announces the recent discovery of the variable radial velocities of ten stars. Two of these, x Carinæ and ι Gruis, were found to be binaries on examining plates taken at Santiago; the other eight were discovered at Mount Hamilton. They are *o*, *f*, and d Tauri, 7 Cameleopardalis, A Boötis, β Coronæ, ξ Cygni, and ζ Cephei.

In the same Bulletin Mr. A. B. Turner publishes a set of elements, and a velocity curve, for the spectroscopic binary ω Draconis, showing the period to be 5·27968 days and the length of the semi-major axis of the orbit to be 2,632,300 km. The velocity of the system is −13·68 km., and the orbit appears to be nearly circular, its eccentricity being only 0·0107.

THE ASTROGRAPHIC CATALOGUE.—We have received from the Catania Observatory the first part of their contribution to the International Astrographic Catalogue. Catania undertook the region dec. +46° to dec. +55°, and the present volume contains the results for the region dec. +50° to +52°, R.A. oh. to 3h. In an introduction Prof. Riccò, the director of the observatory, describes the instruments employed—photographs of the astrographic equatorial and the micrometer appear as a frontispiece—and discusses the methods followed in the reduction of the plates. The positions (1900) of some 7000 stars are included in the present work.

STARS HAVING PECULIAR SPECTRA.—From the examination of Henry Draper memorial photographs, Mrs. Fleming has discovered a number of variable stars and other objects having peculiar spectra, particulars of which are given in Circular No. 132 of the Harvard College Observatory. The Harvard plates show that D.M. +66°·780, given by Dunér and by Krüger as a fourth-type star, gives a spectrum at times which contains no bright lines, whilst at other times the spectrum contains Hβ bright; the intensity of the spectrum also varies in certain regions.

WEAKENED LINES IN SUN-SPOT SPECTRA.—In No. 3, vol. xxvi., of the *Astrophysical Journal*, Mr. Nagaraja, of the Kodaikánal Observatory, gives the wave-lengths of, and discusses, 167 lines which he has found to become weakened in passing from the spectrum of the photosphere to that of sun-spots. The photographs from which Mr. Nagaraja obtained his data were taken with a Rowland grating camera fitted up by Mr. Evershed, and include the region F–D. Considering the forty or so lines due to iron, titanium, and chromium given in this region as enhanced lines by Sir Norman Lockyer, and four more recently announced by Prof. Fowler, Mr. Nagaraja finds that the majority of them are weakened in spots.

Two enhanced lines of iron at λ 5169·07 and λ 5169·22, one enhanced titanium line (λ 5188·87), and two enhanced lines of chromium (λλ 5502·9 and 5621·7) appear to be exceptions, however. With one exception (λ 5284·281, Ti), all the titanium and chromium lines weakened in spots are of the enhanced type. A comparison of the chromospheric and spot-weakened lines shows that only a fraction of the former are weakened in spots, and that a large number of the weakened lines belong to the higher levels of the chromosphere.

EXHIBITION OF PHYSICAL APPARATUS.

THE third annual exhibition of physical apparatus, held under the auspices of the Physical Society of London at the Royal College of Science on December 13, was an unqualified success. Notwithstanding the inclemency of the weather there was a good attendance, many members of the society coming up from distant towns in order to take advantage of the opportunity of inspecting the apparatus itself in lieu of looking through the catalogues of so many makers. Printed and verbal information was available in abundance, and in connection with the former it may not be out of place to offer a word of advice to makers. Any catalogue, however carefully compiled, is in the case of a progressive maker out of date a few months after publication, and is generally supplemented by separate sheets sent out to customers. Very few makers have these sheets cut the same size as their catalogues, and fewer still provide clips at the ends of their catalogues by means of which the additional sheets, sent out punched in the left-hand margin, can be permanently incorporated in the catalogue. They lie about on desks instead until they look dusty and disreputable, and are then consigned to the waste-paper basket, and the information contained in them is forgotten.

As one would naturally expect, the exhibition was strongest on the electrical side, but other branches were not neglected. In general physics, the silica ware exhibited by Messrs. J. J. Griffin and Sons attracted a considerable amount of attention. Bowls of 6 inches diameter, boiling flasks of 3 inches, and tubes of all kinds can now be made of transparent silica, while much larger objects are made of the opaque variety.

Messrs. C. F. Casella and Co. exhibited a telemeter with an 8-feet base, arranged to measure both distances and differences of level, the telescopes rotating about the base and the base about a vertical axis through its centre to eliminate errors. They showed also a direct-reading anemometer on which the revolutions are given by an ordinary engine counter. Messrs. Elliott Bros. exhibited their new "motormeter," or speed indicator, for motor-cars, which is driven from a flat rubber ring attached to the front off-side wheel of the car by means of a friction wheel and flexible shaft.

In heat, the most interesting exhibit was that of the Meteorological Office, which consisted of balloon and kite meteorographs and traces obtained by means of them. Mr. Dines's instrument for recording pressure and temperature on a square inch of thin copper weighs one ounce only, and is most ingenious. Records of ascents of 18 to 20 kilometres, made at the same time at four stations in this country, showed a fair agreement in the temperatures at the same heights over the four stations at comparatively low levels, but considerable differences at high levels.

In photometry there appeared to be a general adoption of the flicker photometer and of the inclined screen method of varying the effect of one of the sources. The movement of the screen is effected by means of a cam rotated by a milled head outside the photometer box, to which a pointer reading on a scale marked directly in candle-power is attached. The uniformity of the divisions is secured by the shape of the cam.

Messrs. A. Hilger, Ltd., exhibited a large spectroscope the telescope of which was moved by a tangent screw graduated on the head directly in wave-lengths. They also had on view a Fabry and Perot interferometer with the interference bands visible, so that the displacement produced by separating the plates could be observed.

Two new photographic lenses giving very flat fields were exhibited, the "Isostigmar" by Messrs. R. and J. Beck, and the "Homocentric" by Messrs. Ross, Ltd.

The work on radio-activity, which is being carried on so vigorously, has raised the electroscope to a position undreamed of a dozen years ago, and amongst the many new forms it now takes may be mentioned one constructed by Mr. C. W. Cook, of Manchester, for Prof. Rutherford, and exhibited by Messrs. J. J. Griffin. It contains a compartment below the leaves in which the radio-active material to be investigated can be placed.

Resistance bridges for the most accurate work appear to be tending towards the enclosed type, with oil circulation to ensure uniformity of temperature. The Cambridge Scientific Instrument Co. showed a Callendar and Griffiths bridge in which plug contacts were replaced by mercury, also enclosed, to prevent the mercury getting to the brass-work.

Several makers seem to be alive to the possibilities of the flat form of resistance coil owing to its compactness and freedom from inductance and capacity. Mr. L. Miller's machine for winding the wire of induction coils in flat vertical sections, the wire passing from outside to inside and back again without a break throughout the whole length of the coil, seems to make it possible to build larger coils without insulation troubles arising. His mica-disc valve, which interposes a disc of mica in a short air gap in the secondary circuit of the coil during the make, and so cuts down the make current that the secondary current is practically unidirectional, should prove a great aid in vacuum-tube work.

Moving magnet galvanometers show a tendency to take the Broca form, in which astaticism is secured by making the poles between the coils consequent poles at the centres of two magnets placed vertically. Instruments so constructed were shown by the Cambridge Scientific Instrument Co. and by Messrs. Clark Fisher and Wadsworth. A very useful addition to the moving coil type of galvanometer was exhibited by Messrs. Gambrell Bros. It consists of a resistance within the galvanometer case, which when placed across the terminals of the instrument renders it aperiodic. One end of it is connected to one terminal of the instrument, and the other to a third terminal, so that it may also be used to diminish the sensitiveness of the galvanometer.

Messrs. Paul exhibited a Campbell vibration galvanometer, which is a moving coil instrument of very short period, the control being of the bifilar type, and the *amplitude* of the oscillations being observed in working with the instrument. Other instruments for small alternating currents were Duddell's thermo-ammeter, on the same principle as his thermo-galvanometer, shown by the Cambridge Scientific Instrument Co., and Cohen's barretter, shown by Mr. R. W. Paul. This instrument is of the bolometer type, the filaments the resistances of which are changed by the current to be measured being those of the 24-volt lamps used on telephone switchboards.

Of instruments intended for commercial work, the iron-clad indicating wattmeter shown by Messrs. Nalder and Thompson may be mentioned, as it illustrates the present tendency to secure larger torques by placing the moving coil in the field of a laminated series or shunt electro-magnet.

Messrs. Nalder Bros. exhibited a compact testing set weighing only 14 lb., capable of measuring insulations up to 2000 megohms with 100 volts, and Messrs. Evershed and Vignoles several of their "meggers" of various ranges up to 1000 megohms.

The Physical Society is to be congratulated on the success of its exhibition, and the various exhibitors on the interest which their display evoked. C. H. L.

ON THE INCIDENCE OF DAYLIGHT AS A DETERMINING FACTOR IN BIRD-MIGRATION.[1]

THE existence of the phenomenon of bird migration is only explicable, like that of all other phenomena of life in both animal and vegetable kingdoms, by the theory of natural selection. It has proved beneficial to certain families of birds in the struggle for existence to wander at certain times of the year in particular directions, and to greater or less distances, such wanderings having led them to regions which were more suitable than others for feeding or breeding. On this general question there can be no difference of opinion at the present day.

But if we leave the general problem and come to deal with specific parts of it, such as the nature of the directing force in migration, or why for certain birds northern latitudes are more suitable as breeding quarters than southern, why for others eastern longitudes than western, we at once enter upon questions regarding which there is

[1] Address to the Scottish Natural History Society, November 7, by Prof. E. A. Schäfer, F.R.S.

great divergence of opinion, and as to which scarcely any two naturalists who have studied the subject are in complete agreement.

The part of the problem that I propose here to consider can be thus stated:—Is there any physiological reason to account for the fact that for that class of birds which we may call the north-south migrants northern latitudes have determined themselves as the most suitable for summer quarters and breeding grounds, and southern latitudes for winter quarters?[1]

The physiological reason for this choice of quarters which most naturally suggests itself concerns the presence or absence of food, or its relative abundance and the means of procuring it. From the Arctic circle, where during winter the whole of nature, sea and land alike, is in the grip of an intensity of cold of which we can form little conception, and which few animals can withstand, birds, at any rate, must move southward, or they would inevitably perish of cold and starvation. It thus appears easy to account for one aspect of the north-south migration problem by referring it to the necessity of avoiding destruction by starvation; but even for this aspect of the question the answer is not quite so simple as at first sight appears. For it fails to account for the distances which such migrations often take, since a passage into the north temperate region alone would suffice to obviate this difficulty; yet this region is, for the most part, passed in the migration of many Arctic birds, which may not stop until a tropical or even a southern hemisphere region is attained; and not only so, but the north-south migrants of the north temperate zone themselves share in the migration, passing away for the winter to a southerly clime. Many of these cannot be said to be driven south by the lack of food, for at the time the migration occurs food is usually still abundant, and there is plenty of food during the whole winter in many of the countries which are passed to support, not only the permanent avine inhabitants, but in some regions myriads of east-west migrants besides.

Moreover, there is evidence that during the Tertiary period the climate of the Arctic circle was entirely different from that which now exists—warm and mild, and abounding with vegetable and animal life—and there was then no necessity for north-south migration on the score of want of food materials. Yet it is impossible not to suppose but that migrations occurred then as now, since the habit of migration is so ineradicably engrained in the nature of the bird that it is difficult to believe that it was not evolved along with the development of the organs of flight.

If we now turn to the other aspect of the north-south migration problem and consider the causation of the movement from south to north, we see that the explanation *re* food supply, which seems easy to formulate for the north to south movement, at once breaks down, for the tropical and temperate regions are at any rate not less abundantly provided with food during summer than the regions of the far north to which the majority of these migrants wend their way. The difficulty is a serious one. The explanation which was used to account for the north to south movement is not available for the opposite movement; some other explanation must be found. Here the weakness of the original explanation manifests itself, for it would be natural to suppose that the reversal of an effect would be the result of the reversal of the cause which produced the effect, and this is not the case in the present instance.

What, then, are alleged to be the reasons for the south to north migration in the spring? One of these supposed reasons is both given and at the same time refuted by Gätke ("Birds of Heligoland," English translation, p. 144) in the following passage:—"From very old times, mainly in consequence of the phenomena which succeeded migration, it was conceived that in spring, with re-awakening life in Nature generally, the reproductive instinct of birds also was roused afresh, and that it was this which urged them to wander to their nesting places; while in autumn, dearth of food and cold admonished them to make a temporary home in warmer latitudes. This view has, in part, held its ground up to recent times, for it is not so long ago that Brehm, in one of his talented discourses on this inexhaustible theme, maintained that the two great factors in the world's action, *Hunger* and *Love*, also dominated the migratory movements of birds. . . . These explanations, however, do not suffice . . . it cannot be the reproductive instinct which prompts birds to set out on their spring migration, for many species do not breed in the first, second, or even third year of their life, and yet migrate to their homes just like those of their congeners who are endowed with the capacity of breeding; nor are they induced to travel by the example of their parents, for they start on their journey alone, and independently." Gätke concludes as follows:—"In regard to this question as to the immediate cause of the departure of birds in their migration . . . we are confronted with a riddle which has hitherto defied every attempt at a solution, and which indeed we may hardly expect will ever be likely to receive a final explanation."

We may take it, then, that the hypothesis that the commencing recrudescence of the generative functions in spring is the determining agent for the migration from south to north does not furnish an adequate explanation of the phenomenon, even if it were certain, as is by no means the case, that such recrudescence begins before the commencement of the movement. It seems obvious that there must be something in the higher latitudes which is favourable to breeding or to the rearing of offspring. Are we to suppose this favourable factor to be relative coldness? *Prima facie* this seems improbable. Other animals, including non-migrant tropical birds, breed freely in the hottest regions of the earth's surface, and warmth is favourable for incubation. Many of the east-west migrants have their breeding grounds in the interior of the great Asio-European continent, which is in the summer much warmer than its western shores. I have been unable to come across any fact which would lead one to suppose that mere diminution of temperature assists breeding. There are, it is true, some fishes and possibly a few other animals that produce their eggs and young in the winter, but in by far the majority it is the warmer season of the year which is occupied with the propagation of the race. We are therefore forced to conclude that the south to north migration is not brought about because of the necessity or advantage of a colder climate for breeding and nesting. Is there, then, any other means of explaining why it is advantageous for certain birds to pass the summer, and especially to breed, in high latitudes, which will equally account for the fact that lower latitudes present corresponding advantages during the winter season? It is an answer to this question that I will now attempt to give.

Let us begin by admitting that bird-migration must have been brought about by the necessity for procuring a sufficient supply of food. The importance of this at all periods is self-evident, but it becomes accentuated in the breeding season, when not only the needs of the parent birds, but also those of their voracious offspring, have to be met. It appears to have been assumed by most writers that for the north-south migrants the higher latitude or summer region of distribution, to which they resort for the breeding season, represents their original home or habitat, to which it is only natural they should desire to return when the desire for breeding comes upon them, and that the migration to lower latitudes is brought about by climatic conditions, such as frost and cold, which render the procuring of food a matter of difficulty or impossibility during winter. There are, however, as has already been pointed out, difficulties in accepting the climatic conditions and accompanying deprivation of food supply as affording the only or even the chief explanation of migration, and more especially of the acquisition by birds of the north-south migratory habit. Thus it fails, as we have seen, to explain the south to north migration in the spring, and would be an inadequate reason for much of the autumnal migration which occurs from the northern temperate zone, such as that of those migratory marine birds the food of which is abundant in the northern seas throughout the winter. It at first sight appears also to fail to account for the fact that with many species of birds autumnal migration occurs before the advent of severe weather, and at a time when the food supply in the higher latitude is as abundant as ever, and that their

[1] For convenience of description the migrants are here assumed to belong to the northern hemisphere.

return from lower latitudes often takes place when the food supply there is more abundant than in the higher latitude to which they are travelling, and may even remain abundant. But although a deficiency of food could not in such circumstances be the immediate determining cause of the movement, an approaching deficiency might, nevertheless, be the ultimate cause, for the most appropriate time for leaving a region which is to become uninhabitable would be determined for each species by natural selection, and might thus appear to have no immediate connection with deficiency of the food supply, although in reality dependent upon it.

It is known, however, that, as has already been stated, during the whole Tertiary period there was a mild or warm climate and abundant vegetation throughout what are now the Arctic and sub-Arctic regions, and it was under these conditions, which presuppose abundance of food supply during the whole winter, even in the highest latitudes, that many existing genera of birds were evolved. We may take it, therefore, that at that period the autumnal migration was not rendered necessary by the approaching severity of the winter months.

This being the case, the question has suggested itself whether the relation of daylight to darkness may not have furnished the factor of most importance in the determination of both the south to north and north to south movements, *in consequence of the necessity to most birds of daylight for the procuring of food.*

In no other class of vertebrate animals is the sense of sight more important than in birds, and in no other is it so highly developed. For detecting and obtaining food most birds depend entirely upon vision, with perhaps, in some, assistance from audition, and, in the case of soft-billed birds, from palpation, but with little or no aid from the olfactory sense, which is in so many animals the most important of the senses in this connection. But vision is not possible in the total absence of light, nor, without special retinal adaptation, in semi-darkness. Hence the great majority of birds—diurnal birds—are dependent upon daylight for the procuring of food; relatively few, such as most owls and nightjars (crepuscular and nocturnal birds), are able to obtain food only in semi-darkness (twilight, moonlight, or starlight); a certain number, *e.g.* many waders, appear to possess retinal adaptation both for ordinary light and for light of low intensity; but, so far as I am aware, no birds, except those which are provided with tactile bills, are able to seek food in total darkness.

From this consideration it is obvious that the proportion of the twenty-four-hour cycle which can be utilised by birds for obtaining food becomes greatly diminished during the winter months in high latitudes, and may be reduced to *nil* within the Arctic circle, while during the summer months the amount of daylight in high latitudes is proportionately increased. Many birds are voracious feeders, and during the hours of daylight are almost constantly engaged in the search for food. It is therefore a necessity that the time during which alone they can see to engage in the search shall not be unduly restricted, as would be the case in high latitudes during the winter, even in parts which are rarely or never frost-bound. This the north to south or autumnal migration provides against. During the breeding season, when the young birds also have to be fed, it is important that the time which can be occupied in the search for food should be prolonged, and this is provided by the south to north migration in the spring. Everyone who has lived in northern latitudes must have been struck with the time occupied by many birds during the long summer days in procuring food for themselves and their young; in fact, no more striking object-lesson of the utility of prolonged daylight for the rearing of their offspring can well be afforded.

The objection might be taken to the relative incidence of daylight and darkness at different seasons being regarded as a factor in causing north-south migration, that in the case of nocturnal birds the course of migration ought to be the other way, viz. from south to north in autumn and from north to south in spring (in the northern hemisphere); but, as has been already pointed out, the so-called nocturnal birds are not, as is popularly supposed, birds which can see in the dark, but birds the vision of which is adapted permanently for light of low intensity, such as twilight. Migration with such birds occurs in the same sense as with diurnal birds, *i.e.* north to south in autumn and south to north in spring (in the northern hemisphere). This is, in fact, what might have been anticipated, seeing how greatly the summer twilights are prolonged in high latitudes.

Again, it might be objected that the circumstance of many birds leaving the higher or lower latitudes before the autumnal or vernal equinox militates against the assumption that the autumnal migration is determined by a relative deficiency of light in higher latitudes during the winter months, and that the vernal migration is determined by the longer daylight which obtains in those latitudes during the summer months. This objection is, however, obviously met in the same manner as with the analogous objection raised to the "food-supply" theory pure and simple, viz. that the most appropriate time for the actual commencement of migration will have been determined for each species by the process of natural selection.

Further, the assumption that the relation of light to darkness rather than severity of climatic conditions has been the determining factor in producing the north-south migrations would better explain the singular constancy in the times of year at which these migrations occur. For not only are the times of migration in many cases independent of the actual climatic conditions which are supposed to be the determining cause of the movement, but the climatic conditions themselves vary considerably from year to year in their inception and progress. On the other hand, the incidence of the proportion of light to darkness is a constant factor, and might even be conceived to be operative in exciting the migratory instinct into activity in the same manner as it is here assumed to have been the original determining cause of north-south migration. That there are other stimuli seems probable from the circumstance that some birds have their winter quarters in the equatorial region, where the proportion of day to night does not vary throughout the year. There are, however, very regular seasonal changes in that region, which are accompanied by marked differences in amount of daylight, and for those migrants which winter there these seasonal changes may serve as the initiating stimulus to northerly migration. That it is a result of developmental changes in the sexual organs is improbable, since sexually immature individuals are also subject to the migratory tendency; nor is there any evidence that such changes begin prior to migration. In any case, the regularity with which migration occurs indicates that the exciting cause must be regular. There is no yearly change, outside the equatorial zone, that occurs so regularly in point of time as the change in the duration of daylight. On this ground this may well be considered a possible determining factor in migration, and it has the advantage over other suggested factors that it applies to the northerly as well as to the southerly movement.

Besides the north-south migrations with which we are more immediately concerned, there are also the great east-west vernal and autumnal movements which are so prominent a feature in the eastern parts of these islands, and also migrations of a more local character, both of which merit some allusion in connection with the general question of migration.

As regards the east-west movements, which are, in fact, for many species a part of the general north-south migrations,[1] it has been supposed that these divarications from the main north-south stream have become evolved either as the result of changes in the earth's surface, which have produced a modification of the general north-south trend,[2] or that they are the expression of the course of expansion of the breeding range of the species as it approaches its northern limit.[3] The physiological reason for the east-west movement must ultimately be sought, as in the north-south movement, in facility for the obtaining of food, and it may fairly be assumed that in the case

[1] For the evidence of this see Gätke, "Heligoland an Ornithological Observatory," pp. 39-43. Also the British Association reports on bird migration, especially the "Digest," by W. Eagle Clarke, in report of Liverpool meeting, 1896.

[2] Evans, Cambridge Natural History, "Birds," p. 18.

[3] Dixon, "The Migration of Birds," 1897, p. 35; also p. 40.

of species which show no north-south tendency in migration and which are confined to the temperate zones there is sufficient opportunity, even in shortened days, of obtaining such food as they require for subsistence in the region to which they have betaken themselves for winter quarters. Many of these east-west migrants are either graminivorous or live on insects and grubs which they seek in the ground or on trees. In the summer their food is most abundant in the great grain-producing or forest-clad central regions of the Asio-European continent, while in the winter they are compelled to seek their subsistence in a less severe climate.

Another kind of migration is that which may be produced by local conditions of food and pressure of bird population. If in any particular zone food of appropriate character is obtainable at all times of the year in sufficient abundance, the necessity of migration to a higher or lower latitude is no longer necessary for a specific number of individuals, and their migration, and that of their descendants, will accordingly tend to limit itself to that zone, within which such migration as does occur will be more or less local.

Newton[1] suggested that the arrival of a large batch of migrants in a particular area or zone which is already occupied by birds of the same species may compel the individuals of that species which are in possession to move on in any direction where food is readily obtainable. It is perhaps more probable that later migrants into a zone already occupied by birds of the same species or habits may, on finding others already in possession, themselves push on into other regions. In this case the *later* migrants of species which vary in the extent of their migration would tend also to become the *more extensive* migrants, and would by natural selection transmit this tendency to their descendants. This conforms to the statement that those individuals of a species which migrate to the higher latitudes in the range of distribution of the species start their spring migration later than the individuals which migrate to less high latitudes.[2]

The theory that bird migration in the Holarctic area was originally determined by the encroachment and subsequent retreat of the ice-sheet over the temperate zone during the Glacial epoch (or epochs) is one which appears impossible to accept. Such a theory in its bare form involves the assumption that the habit of migration which so extensively pervades the avine class of vertebrates has been acquired during comparatively recent geological times, for which there is neither evidence nor probability. When we consider how extensively diffused is the tendency to migration of some kind amongst birds, it appears reasonable to assume that the habit was acquired at a comparatively early period of their evolutionary history. It may even be that the advantage gained by a more and more extensive movement of the kind was the predetermining cause, in the hands of natural selection, of the complete evolution of the avine type of vertebrate.

I have been able to find in the literature only two references dealing directly with the subject of the influence of light on bird migration. Seebohm ("The Geographical Distribution of the Family Charadriidæ," London, 1888, p. 34) writes as follows:—"The first migrations of the ancestors of the Charadriidæ were probably not in search of *warmth*, for the climate of the Polar Basin was in those remote ages mild enough: nor in search of *food*, which was probably abundant all the year round; but in search of *light* during the two or three months when the sun never rose above the horizon. The habit of migration thus formed became deeply rooted in the species, in accordance with the law of heredity: and doubtless acquired additional force when the terrors of a glacial epoch exterminated the conservative party amongst the Charadriidæ (if any of them were foolish enough to neglect to adapt themselves to the changed circumstances), and compelled the survivors to extend their migrations far and wide, until the shores of nearly all the rest of the world were visited on passage, or included in the winter range of some species of the family."

Seebohm evidently realised that, however warm the circumpolar area and however well stocked with food, it would be impossible for birds to subsist there all the year round *on account of the absence of daylight during the winter months*. It is the more strange that he should have failed to perceive the obvious corollary that these birds might seek such high latitudes during the summer months in the breeding season on account of the advantage offered for the procuring of food by the prolonged daylight.

Some fourteen years prior to the publication of Seebohm's work there appeared in the *Academy* (1874, vol. vi.; p. 262), under the head of "Notes and News," the following paragraph,[1] which, however, bears no indication of the source whence the information it contains was derived:—

"The aged poet Runeberg, the greatest scald that Sweden has ever had, has been in extremely weak health for many years past. It appears that as he has lain on his sick bed, at Helsingfors in Finland, he has occupied himself by close observation of the habits of birds, and specially with regard to the causes of migration, and he has at last put forward a singularly beautiful theory on the latter point. He believes, in fact, that it is the longing after light, and that alone, that draws the birds southwards. When the days shorten in the north, the birds go south, but as soon as ever the long northern nights (*sic*) set in, with all their luminous and long-drawn hours, the wanderers return to their old haunts. It is generally supposed that they move southward to get more abundant food; but why, asks Runeberg, do they leave their rich hunting-grounds to return to the north? The central regions of Europe are in every way more desirable than the wastes of Scandinavia. Only one thing is richer there, and that is light. The same instinct that makes plants firmly rooted in the ground strain towards the light, spreading upwards in search of it, works in the birds, who, on their free wings, fly after and follow it. This very suggestive and poetical notion is further carried out by reference to various analogies in natural history, and the final sentence is quite epigrammatic: 'The bird of passage is of noble birth; he bears a motto, and his motto is *Lux mea dux*.'"

The idea which is given voice to in the above paragraph bears a certain resemblance to that which I have endeavoured to set forth in this paper, but on close consideration it will be seen that the resemblance is purely superficial. What I have tried to urge is, not that these north-south migrants seek light *quâ* light, but that the sense by which alone they are for the most part able to obtain food necessitates their passage to regions where at one or another time of year there will be sufficient daylight to procure it. This is a special part of the general problem of food supply, itself an all-important agency in natural selection, which last there can be no doubt has been instrumental in determining the habit of migration. The theory attributed to Runeberg, in so far as it seeks to explain north-south migration by the endeavour of the bird to follow light alone without reference to the ultimate reason for such movement, in no way explains why birds rather than other animals should require light, and may well have merited the criticism to which it was at the time subjected by Prof. Newton (NATURE, September 24, 1874, p. 415), who pointed out that since "the southern movement not only begins but is with many species in great part accomplished long before the autumnal equinox, when consequently the birds are journeying to increasingly shorter days; and in like manner their northward movement is set on foot before the vernal equinox," the theory (that it is light alone that is the attraction) "contains its own refutation."

The object of this paper has been to endeavour to give a reasonable explanation of the north-south tendency, which is the most prominent feature of bird-migration. No attempt is made to explain all phenomena of migration. Obviously there are some migrations which cannot be explained on the assumption that the object of move-

1 "Dictionary of Birds," art. Migration.

2 This appears to be the case with the swallow (see W. Eagle Clarke, British Association Report, 1901, p. 10), the individuals which are to summer in Scandinavia passing through this country after our own swallows have arrived. Similarly, the return of the Scandinavian swallows also appears to be somewhat later than ours (middle of September, p. 12). (See also the same author's "Digest," British Association Report, 1896, p. 17).

1 The paragraph was copied in the *Times* for September 18, 1874.

ment is to obtain more extended daylight. This, however, is not to be wondered at, since the quest of daylight is itself only a part of the greater problem of food supply. Any condition, local or other, which tends to restrict food supply in a particular area must produce migration from that area into more favoured areas. This is alone sufficient to account for the winter migrations which many birds exhibit, sometimes to a large extent, and for the localised migrations which some species, not usually regarded as migrants, exhibit in spring and autumn, moving from one area into another, not necessarily in a different latitude, although often of a different altitude. Further, it must be borne in mind that some birds, and those not few in number, find both sufficient food and sufficient daylight to acquire it in the same region all the year round, and exhibit no tendency to migrate. This can in no way be employed as an objection to the view that the true north-south migrants have been driven to seek more extended daylight for the purposes of obtaining a sufficiency of food; it would equally apply to any other explanation that might be given to account for the migratory tendency, and could only be used to prove that there is no necessity for any migration at all, which, as Euclid would say, is absurd. Given a food supply adequate in nature and amount to maintain the species in any region, and sufficient light all the year round to procure it, there would be no need for migration.

But these are not, and never have been, conditions which obtain in all regions and for all species. On the contrary, a very large number of species appear to require the prolonged daylight of the northern summer to procure a sufficiency of food for themselves and their offspring, while, apart from severity of climate, the shortened hours or absence of daylight which supervene there necessitate that they should pass the winter months in southern latitudes. Thus we can comprehend how the north-south migratory instinct became evolved, and we no longer wonder at the existence of this phase of the phenomenon. That the great east-west migrations are more complex and more difficult of explanation I am free to admit, but it must not be forgotten that we know, on the whole, less about these, and especially less about the climatic and other conditions which accompany them and may be supposed to produce or influence them, than we do about the influences to which the north-south migrants are exposed. The fact that we are not in a position to solve the whole of a complicated problem need not prevent our attempting to deal with any part for which our existing knowledge enables us to devise an explanation. If I have approached the question entirely from a physiological aspect, it is because it is in the main a physiological question. Nevertheless, no physiologist has hitherto attempted to deal with the subject, and it is only with diffidence that I encroach upon a domain which the morphologist has up to the present regarded as his own.

CRETAN EXPLORATION.

AN appeal is made by Dr. Arthur J. Evans, F.R.S., for funds to complete the excavation of the "Palace of Minos," which has now been carried on for seven years. At the beginning of the present year it was thought that supplementary explorations on a comparatively small scale would be sufficient, and that by the close of the season something like finality might be attained as regards at least the palace site of Knossos. This forecast, however, was by no means borne out by the result. The season's work, which was intended to be of a more or less supplementary nature, broadened out into a somewhat extensive excavation, the result of which is to show that another great campaign must be carried through before the excavation of the palace site at Knossos approaches completion. It is estimated that at least another 3000*l.* is required to complete the work, and this must be met by public subscription, for, as Dr. Evans points out, in this matter it is unfortunately impossible for an English explorer to rely, like his French, German, and Italian colleagues, on Government grants or large subventions from national academies. Writing in support of the appeal in the *Times* of November 21, Prof. C. Waldstein, referring to Cretan exploration as a scientific labour which has brought credit to the British nation all over the world, says:—"In any other European country the Government would have subsidised, if not paid, all the expenses of what can in no way be considered a private enterprise. . . . Does not a wider public take some interest in the higher research carried on by the scientific representatives of the nation, and can the wealthier classes in England not be brought to give material support to the efforts of those who thus stand for the nation's higher culture? Is it impossible to hope for a Government subsidy? If it be not the 'tradition,' good traditions can be inaugurated by those who lead the nation. No amount of immediate effort to raise our industries by direct technical education will prepare us to cope with the competition of the other leading nations of the world. We must raise the tone of intellectuality by arousing the national interest in the highest forms of intellectual life." Subscriptions for the Cretan Exploration Fund can be sent either to Mr. G. A. Macmillan, St. Martin's Street, W.C., or to Messrs. Robarts, Lubbock, and Co., Lombard Street.

A LUNAR "NEW JERUSALEM."

A PAMPHLET has been received containing a series of lectures by the Rev. G. B. Berry on "The New Jerusalem," with a preface by the Lord Bishop of Exeter. With the spiritual interpretation of the Apocalypse we are not concerned in these columns, but an astonishing speculation put forward in the last lecture demands a word of comment. Mr. Berry suggests that the invisible part of the moon has the same size and shape as the mighty pyramid which, according to Revelation, forms the heavenly Jerusalem. Eventually the lunar hemisphere visible to us is to bury itself in the earth, and the pyramidal portion is to project above "the rack and ruin of the elements" caused by the catastrophe, and to be the Celestial City in which the faithful will pass eternity. As a vision, this picture may appeal to imaginative minds, but from the point of view of celestial mechanics it can scarcely be taken seriously. A pyramid of the dimensions of that upon which Mr. Berry's New Jerusalem rises tier upon tier would be crushed by its own weight even if it were built of steel. As, however, the structure is visionary, we imagine that this material fact affords no valid objection to it. The changed moment of inertia of a moon with the invisible side of a pyramidal form would necessitate modification of the whole theory of the physical librations of our satellite; but perhaps Mr. Berry does not appreciate the force of this difficulty. He is certainly not familiar with the theory of tidal friction or with the fact that Laplace, who studied the physical librations, showed that one side of the moon always faces the earth because that position is one of dynamical stability. A fuller knowledge of celestial mechanics might have made Mr. Berry hesitate before erecting such a visionary structure as he describes upon so slender a foundation. His views would have pleased mediæval schoolmen, but modern science demands that even the most fascinating hypothesis should be based upon results of observation capable of being put to the test of inquiry rather than upon "revealed truth" to be accepted without criticism.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE governing body of the South-Western Polytechnic has appointed Dr. Louis Lownds head of the department of physics. Dr. Lownds is the author of papers on the thermoelectric and thermomagnetic properties of bismuth crystals and on other subjects. Dr. W. H. Eccles, formerly head of the joint mathematical and physical department, has been made head of the department of mathematics.

THE annual distribution of prizes and certificates at the Borough Polytechnic Institute was held on Thursday, December 12, when Sir Edward Carson, K.C., M.P., presented the prizes and delivered an address. Mr. Spicer, the chairman of the governing body of the institute, in the course of his remarks referred to the building extension

which is now being carried out at the polytechnic, at a cost of 12,000*l.*, toward which the late chairman of the governing body, Mr. Edric Bayley, has generously contributed the sum of 5000*l.*, the remainder being made up by a grant from the London County Council. Mr. C. T. Millis, the principal, in his report, stated that there were nearly 3000 individual students in attendance during the past session, of whom 330 were day students.

We have received the calendar of the Camborne Mining School, Camborne, for 1907–8. This school, now in the twentieth year of its existence, has rapidly expanded, and has proved very successful in giving facilities to students for acquiring a thorough knowledge of metalliferous mining. The success has been largely due to the organisation of a systematic course of practical mining, the South Condurrow, now known as the King Edward mine, having been purchased for the purpose in 1897. Students there obtain an acquaintance with practical mining, ore dressing, and engine testing, as well as practice in mine surveying under the supervision of practical men under the direct authority of the school. Moreover, in consequence of the situation of the school in the centre of the chief mining district of Cornwall, students have the privilege of visiting the mines. The calendar is illustrated by a number of admirable photographic views, many of which have been taken by Mr. J. C. Burrow, the leading exponent of underground photography. The photograph here reproduced represents the so-called "cathedral" at the 460-feet level of King Edward mine.

View underground in King Edward Mine.

Mr. Haldane, M.P., unveiled a statue of the King at University College School, Frognal, Hampstead, on Saturday, December 14. The statue has been erected in a niche above the main entrance, and is presented to the school by the architect, Mr. Arnold Mitchell, in commemoration of the opening of the school by the King on July 25. In a subsequent address Mr. Haldane said:—"There is no subject of greater general importance than education, and if Prince Albert had lived there is no doubt that education would have been ten years in advance of its present stage. The work at South Kensington, as is well known, is largely due to his instigation and interest, and the new Technological Institute which will begin in the coming year will be a natural outcome of that work. By means of it we hope to be brought more into line with other nations."

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, November 7.—"The Diurnal Variation of Terrestrial Magnetism." By Prof. Arthur **Schuster**, F.R.S.

In a previous communication (Phil. Trans., vol. clxxx., p. 467, 1889) the author proved that the diurnal variation of terrestrial magnetism had its origin outside the earth's surface, and drew the natural conclusion that it was caused by electric currents circulating in the upper regions of the atmosphere. If we endeavour to carry the investigation a step further, and consider the probable origin of these currents, we have at present no alternative to the theory, first proposed by Balfour Stewart, that the necessary electromotive forces are supplied by the permanent forces of terrestrial magnetism acting on the bodily motion of masses of conducting air which cut through its lines of force. In the language of modern electrodynamics, the periodic magnetic disturbance is due to Foucault currents induced in an oscillating atmosphere by the vertical magnetic force. The problem to be solved in the first instance is the specification of the internal motion of a conducting shell of air, which shall, under the action of given magnetic forces, determine the electric currents producing known electromagnetic effects. Treating the diurnal and semi-diurnal variations separately, the calculation leads to the interesting results that each of them is caused by an oscillation of the atmosphere which is of the same nature as that which causes the diurnal changes of barometric pressure.

The mathematical analysis is simple so long as we take the electric conductivity of the air to be uniform and constant; but the great ionisation which the theory demands

requires some explanation, and solar radiation suggests itself as a possible cause. Hence we might expect an increased conducting power in summer and in day-time as compared with that found during winter and at night. Observation shows, indeed, that the amplitude of the magnetic variation is considerably greater in summer than in winter, and we know that the needle is at comparative rest during the night. The variable conducting power depending on the position of the sun helps us also to overcome a difficulty which at first sight would appear to exclude the possibility of any close connection between the barometric and magnetic variations; the difficulty is presented by the fact that the change in atmospheric pressure is mainly semi-diurnal, while the greater portion of the magnetic change is diurnal. This may, to some extent, be explained by the mathematical calculation, which shows that the flow of air giving a twenty-four-hourly variation of barometric pressure is more effective in causing a magnetic variation than the corresponding twelve-hourly variation, but the whole difference cannot be accounted for in this manner. If, however, the conductivity of air is greater during the day than during the night, it may be proved that the twelve-hourly variation of the barometer produces an appreciable periodicity of twenty-four hours in the magnetic change, while there is no sensible increase in the twelve-hourly magnetic change due to the twenty-four-hourly period of the barometer.

A good test of the proposed theory may be found in a closer examination of the diurnal magnetic changes in the equatorial regions, because, owing to the inclination of the magnetic to the geographical axis, the magnetic changes ought to have a term which does not depend on local time, but on the time of the meridian containing the geographical and magnetic pole. This term has its greatest importance at the equator and at the time of the equinox.

The value of the conductivity necessary to explain the diurnal variation in the manner indicated depends on the thickness of the layers which carry the currents. If e be the thickness and ρ the conductivity, and the amplitude of oscillation in the upper layers is assumed to be the same as that deduced from the barometric variation, it is found that $\rho e = 3 \times 10^{-6}$. If e is equal to 300 kilometres, the conductivity would have to be as high as 10^{-13}, while the observed conductivity of air at the surface of the earth under normal conditions is of the order 10^{-24}; at a height at which the pressure is reduced to one degree per square centimetre, the conductivity would be 10^{-18}, assuming the rate of re-combination to be independent of temperature and the ionising power to be the same. The conclusion is that there must be a powerful ionising agent in the upper layer of the atmosphere.

November 21.—"The Silver Voltameter." Part I. "On a Comparison of many Forms of Silver Voltameters." By F. E. **Smith**; and "A Determination of the Electrochemical Equivalent of Silver." By F. E. **Smith** and T. **Mather**, F.R.S.

Part II. "The Chemistry of the Silver Voltameter." By F. E. **Smith** and Dr. T. M. **Lowry**. Communicated by Dr. R. T. Glazebrook, F.R.S.

Part I.—Very large voltameters were experimented with. Four of the kathode bowls had a capacity of 500 c.c. each, and in general from 300 c.c. to 400 c.c. of electrolyte were employed. The anodes were coated with electrolytic silver. With a Rayleigh form of voltameter containing an electrolyte of pure silver nitrate, the mean of fifty-two determinations of the electrochemical equivalent of silver was 1·11827 milligrams per coulomb, the current being indirectly measured by the Ayrton-Jones balance. With a Richards's form of voltameter, in which the pot had previously been baked in an electric furnace, the value 1·11828 was obtained, and with a syphon and other modified forms of voltameter the value 1·11827 resulted, pointing to little or no irregularities in the large-size Rayleigh form of voltameter. Deposits were made when the voltameter was subject to a gaseous pressure of 2·4 cm. of mercury, and were found to be identical with those made at atmospheric pressure. The temperature coefficient is probably *nil*, and is not greater than 1 part in 1,000,000 per 1° C. The range in the current intensities was from 0·5 ampere to 8 amperes.

Part II.—Before a definite value could be assigned to the electrochemical equivalent of silver it was necessary to demonstrate that silver nitrate solutions, giving constant products, could be obtained. This was done by preparing silver nitrate from electrolytic silver, from much used silver nitrate, and from commercial samples of the salt. Attempts to confirm the observations of Novak, Rodger and Watson, Kahle, van Dijk, and others, on the effect of repeated electrolysis of a solution, show that in the form of voltameters described in Part I. there is no increase in the deposit with continued use of a solution which is comparable with that obtained by the observers mentioned. High values for the electrochemical equivalent are obtained if the solution contains oxide, carbonate, chloride, nitrite, or hyponitrite; low values are caused by acid. Silver chlorate and silver perchlorate appear to give normal deposits, but are more troublesome in use, and have no advantage over the nitrate.

"On the Normal Weston Cadmium Cell." By F. E. **Smith**. Communicated by Dr. R. T. Glazebrook, F.R.S.

In the past many investigators have pointed out that the depolariser may produce variations in the E.M.F. so great as 0·002 volt. A mode of manufacture of mercurous sulphate was first sought which could be relied on to give a constant product. The salt was prepared in four ways:—(1) electrolytically; (2) by chemical precipitation; (3) by re-crystallisation from a solution in strong sulphuric acid; (4) by the action of fuming sulphuric acid on mercury. The mean E.M.F. of the cells set up with the electrolytic salt is 1·01828 volts; with No. 2 product, 1·01830 volts; (3) gives 1·01832 volts, and (4) 1·01831 volts. The effect of the size of the crystals of the depolariser, to the importance of which attention has been directed by H. v. Steinwehr, was investigated by using crystals varying in size from 5 to 30 microns, and it is concluded that no large crystals which are sufficiently soluble to act as an efficient depolariser can give an E.M.F. appreciably lower than that due to crystals from 5 to 30 microns long. The recuperative power of the cell was tested by short-circuiting for from one minute to five days. The temperature coefficient for the range 10° C. to 30° is given by

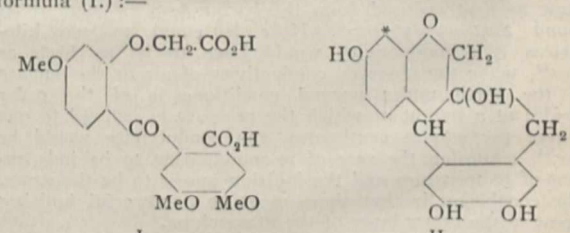
$$E_t = E_{17} - 3{\cdot}4_5 \times 10^{-5}(t-17) - 0{\cdot}066 \times 10^{-5}(t-17)^2.$$

Geological Society, November 20.—Sir Archibald Geikie, K.C.B., Sec.R.S., president, in the chair.—Glacial beds of Cambrian age in South Australia: Rev. Walter **Howchin**. The known extension of these beds is 460 miles from north to south. The greatest width across the strata is about 250 miles. The beds form part of a conformable series, with Cambrian fossils in the upper part. The rocks above the glacial beds are purple slates and limestones; below they are quartzites, clay-slates, and phyllites, passing into basal grits and conglomerates, resting on a pre-Cambrian complex. The beds consist of a ground mass of unstratified indurated mudstone, carrying boulders up to 11 feet in diameter. The thickness of the glacial series has been proved up to 1500 feet. The commonest rock-type among the boulders is a close-grained quartzite. The discovery of ice-scratched boulders has indicated the origin of the beds. The striæ are often as distinct as those in a Pleistocene Boulder-clay. Eighty definitely glaciated boulders have been secured, and other erratics too large for removal noted. Under pressure and movement in their bed some boulders exhibit abrasion, but this produces features not to be confounded with glaciation. In the movement due to pressure, which induced cleavage, some stones have become distorted, and many show pseudo-striation on exposed surfaces. The lines, however, are of equal size and depth, and parallel to each other over wide surfaces, while the glacial striæ are patchy in their occurrence, of varying intensity, and divergent in direction. Mr. H. P. Woodward's suggestion, that the "Boulder-clay" had its origin from "floating ice," is considered most in accordance with facts.—A formation known as "glacial beds of Cambrian age" in South Australia: H. **Basedow** and J. D. **Iliffe**. Eight miles south of Adelaide an exposure of the conglomerate is bounded to the east by alternating quartzitic and argillaceous bands of rock, comprising the central and western portions of a fan-fold, partly cut off by a fault. Further evidence of stress in this margin is given. On

the west side the conglomerate is bounded by the "Tapley's Hill Clay-slates," and there is evidence that the conglomerate is isoclinally folded. In that portion of the conglomerate adjacent to its confines, "boulders" of quartzite are apparently disrupted portions of quartzite-bands, since these are in alignment with the truncated portions of bands still existing, and are of similar composition. The presence in the conglomerate of boulders of rocks foreign to the beds that border the conglomerate is not yet accounted for.

Entomological Society, November 20.—Mr. G. H. Verrall, vice-president, in the chair.—*Exhibits.*—W. **West**: Examples of *Tropideres sepicola*, F., taken in the New Forest near Matley Bog, July 7, 1904; *Oxylaemus variolosus*, Dufs., from Darenth Wood, March 2, 1903; and *Apion annulipes*, Wenck, from Darenth Wood, August 27, 1905.—H. J. **Turner**: Two cases to show the complete life-histories of *Coleophora onosmella* and *C. bicolorella*.—Dr. F. A. **Dixey**: Several species of five African genera of Pierine butterflies for the purpose of showing the strong mimetic parallelism that existed between them.—W. **Gardner**: A remarkably small specimen of *Meloë proscarabaeus*, with an example of the normal size.—W. G. **Sheldon**: A case containing many examples of *Araschnia levana*, var. *prorsa*, and intermediates, bred from larvæ found in the department of the Aisne, France, in June last.—Dr. T. A. **Chapman**: Specimens of *Araschnia levana*, type, bred 1907, to give a fuller view of this form in assistance to Mr. Sheldon's report.—Mr. **Sheldon** also showed strings of the ova *in situ* on nettle, these being base to apex, and in position resembling those of *Polygonia c-album*.—G. **Arrow**: A specimen of a handsome exotic cockroach (*Dorylaea rhombifolia*) found alive in the Natural History Museum, one of an apterous species inhabiting China, India, Madagascar, South Africa, &c.—Dr. G. B. **Longstaff**: A case containing thirty-five Ithomiine butterflies of eleven species, belonging to six genera, taken at Caraccas, Venezuela, some 3600 feet above sea-level, and affording a striking exception to Darwin's principle that closely allied forms are not usually found together.—Lieut.-Colonel N. **Manders**: A collection of some 200 specimens of tropical butterflies belonging to the genera Melanitis, Mycalesis, Attella, Papilio, and Catopsilia, which had been subjected to abnormal degrees of temperature, mostly in the pupal stage. The object of the experiments was to ascertain the effect of climate on the colours of tropical butterflies.—W. J. **Kaye**: A convergent group of Heliconine butterflies, from the Potaro Road, Potaro River, British Guiana.—*Papers.*—Mimicry in North American butterflies of the genus Limenitis (Basilarchia): Prof. E. B. **Poulton.**—The life-history of *Lomecosus strumosa*, F.: H. St. J. **Donisthorpe.**

Chemical Society, December 5.—Sir William Ramsay, K.C.B., F.R.S., president, in the chair.—The affinity constants of bases determined by the agency of methyl orange. Preliminary note: V. H. **Veley.** The author has applied his tintometric method to the determination of the degree of hydrolysis of hydrochlorides of a large number of organic bases ranging in type from hydroxylamine to cinchonidine. Several results are found to be in accordance with the expression of Arrhenius, $k_b/k_w = (1 - x)v/x^2$, whilst in the case of bases of analogous composition the ratio of the hydrolysis values found is nearly equal to the ratio of the heats of neutralisation with hydrochloric acid.—The constituents of essential oil of nutmeg: F. B. **Power** and A. H. **Salway.** Ceylon nutmeg oil contains eugenol, *iso*eugenol, *d*-pinene, *d*-camphene, dipentene, *d*-linalool, *d*-borneol, *i*-terpineol, geraniol, a new alcohol yielding on oxidation a diketone, a citral-like aldehyde, safrole, myristicin, myristic acid (free and in the form of esters), formic, acetic, butyric, and octoic acids, and a new monocarboxylic acid, $C_{13}H_{18}O_3$, all in the form of esters.—The resolution of *sec*-octyl alcohol: R. H. **Pickard** and J. **Kenyon.** *d-sec*-Octyl hydrogen phthalate is obtained by fractional crystallisation of the brucine salt from acetone and the *l*-salt by fractional crystallisation of the cinchonidine salt from aqueous acetone.—The velocity of reduction of the oxides of lead, cadmium, and bismuth by carbon monoxide, and the existence of the suboxides of these metals: F. J. **Brislee.** The results of the experiments confirm Tanatar's statement that the suboxides are definite chemical compounds, but do not prove their stability.—The relation between unsaturation and optical activity, part i., the menthyl and bornyl esters of β-phenylpropionic, cinnamic, and phenylpropiolic acids: T. P. **Hilditch.** The boiling points and specific gravities increase with increase of unsaturation, but the refractive indices rise with the change to an ethylenic linking, but fall to an intermediate value for the further change to an acetylenic linking. Walden's view that increase of saturation is accompanied by increase of optical rotation is confirmed so far as the change to an ethylenic linking is concerned, but not with reference to the effect of a triple bond on the optical rotation.—Methyl ethers of some hydroxyanthraquinones: A. G. **Perkin.**—The colouring matters of the stilbene group, part iv., action of caustic alkalis on *p*-nitrotoluene and its derivatives: A. G. **Green,** A. H. **Davies,** and R. S. **Horsfall.**—The replacement of alkyl radicles by methyl in substituted ammonium compounds: H. O. **Jones** and J. R. **Hill.** The authors find that in amines or quaternary ammonium compounds the ethyl, propyl, *iso*propyl, butyl, *iso*butyl, and *iso*amyl groups are all replaced by methyl, sometimes in the cold, but more easily on heating with methyl iodide.—Note on the formation of abnormal platinichlorides. A correction: A. E. **Dunstan.** The three platinichlorides of the type $B_4H_2PtCl_6$, described previously, are now found to belong to a group of such substances already noted by Werner and others.—The nitrates of dimethyl- and methylethylthetine menthyl esters: S. **Smiles.** These were prepared by precipitating aqueous solutions of the bromides with aqueous ammonium nitrate.—Synthesis of brazilinic acid and the lactones of dihydrobrazilinic and dihydrohæmatoxylinic acids. Preliminary note: W. H. **Perkin** and R. **Robinson.** Brazilinic acid is formed when trimethylbrazilin is oxidised by permanganate, and on reduction is converted into the lactone of dihydrobrazilinic acid. Brazilinic acid is produced synthetically by condensing metamethoxyphenoxyacetic ester with *meta*hemipinic anhydride, and must be represented by the following formula (I.):—



I. II.

From this and other syntheses it is concluded that brazilin, the colouring matter of Brazil wood, must be represented by the constitutional formula (II.) first assigned to it by Werner and Pfeiffer, and that hæmatoxylin, the colouring matter of logwood, is derived from that of brazilin by the introduction of a hydroxyl group at the point indicated by the asterisk in formula (II.).—Condensations of ketones containing the group

$$CH_2.CO.CH:$$

with esters in presence of sodium ethoxide: R. W. L. **Clarke,** A. **Lapworth,** and E. **Wechsler.**—Acylogens and thiocarbamides: A. E. **Dixon** and J. **Taylor.**—The alkyl compounds of gold: W. J. **Pope** and C. S. **Gibson.**—The refractive power of diphenylhexatriene and allied hydrocarbons: Miss I. **Smedley.** The results recorded show that in each case the refractive power of the group increases with the number of unsaturated groups present, and that the influence of the hexatriene structure is always greater than that of the benzene ring.

Royal Anthropological Institute, December 3.—Prof. W. Gowland, ex-president, in the chair.—Some Papuan children's games: Captain F. R. **Barton.** The games dealt with are those played by children in British New Guinea, and included fishing games, cat's cradle, hide and seek, and others. Whilst the games are being played the children sing, and the songs are of particular interest, as in many cases the words are quite archaic, and the meaning has been lost.

CAMBRIDGE.

Philosophical Society, October 28.—Dr. Hobson, president, in the chair.—The longitudinal impact of metal rods with rounded ends (second paper): J. E. **Sears.** In this paper the effect of the rounded ends is discussed mathematically by means of a combination of the theories of Hertz and St. Venant. Further experimental results are brought forward for purposes of comparison. In these experiments rods of unequal lengths were used, and observations made both of the durations of impact and of the velocities of rebound. The results in nearly every case agreed within 1 per cent. with those given by the theory. Interesting laws are found for the variation in the duration of the impact when the length of *one* of the rods is continuously increased, and also for the case when the velocity of impact is allowed to vary. The paper concludes with a suggestion as to the application of the theory to plane-ended rods, and a calculation of the stresses set up at the ends of the rods during impact.—The fatigue of secondary radiation due to radium rays: J. A. **Crowther.** The object of the experiments was to ascertain if the continuous impact of the radium radiations upon a metal plate over a prolonged period of time produced any alteration in the amount of secondary radiation given out by the plate. Experiments were made both with the β and γ rays, and also with the α rays. The results of the experiments showed (1) that the continuous impact of radium rays upon a metal plate does not cause any diminution in the amount of secondary radiation given out by the metal under the action of the radium rays themselves; (2) that the continuous impact of radium rays upon a metal plate does produce an alteration in the amount of secondary radiation given out by the plate under the action of Röntgen rays, in amount similar to that produced by the continuous impact of Röntgen rays; (3) that the continuous action of radium rays produces a very marked diminution in the amount of secondary radiation given out by the plate under the action of ultra-violet light.—Laws of motion: P. V. **Bevan.**—Ionisation by ultra-violet light: Prof. **Thomson.**—The asymptotic approximation to functions defined by highly convergent product forms: J. E. **Littlewood.**

PARIS.

Academy of Sciences, December 9.—M. A. Chauveau in the chair.—An apparatus designed for stars composed partly of gas and partly of solid particles, and capable of giving separately the image of each of the two elements: H. **Deslandres.** A photograph of the star spectrum is made, and from the negative a screen is made with a diaphragm cutting out any desired lines, and this screen is placed in the focal plane of the spectrum. A diagram of the complete apparatus is given, which is arranged so that the spectrum photographed may include either the lines of both gas and solid particles or those of the gas or particles separately. The apparatus is easily applicable to comets, nebulæ, the middle and upper chromosphere of the sun during eclipses, and even the corona.—The supposed poisonous nature of Hungarian beans: L. **Guignard.** Contrary to the results obtained by MM. Evesque, Verdier, and Bretin, the author has not been able to obtain the smallest trace of hydrocyanic acid from Hungarian beans (*Haricots de Hongrie*). The method of estimation of the hydrocyanic acid used by the above-mentioned chemists is subjected to a critical examination, and the author's own method described in detail.—The claims of M. Loeb in the question of experimental parthenogenesis: Yves **Delage.** A reply to some criticisms of M. Loeb on the author's work.—Some Lepidostrobus from the Pyrenees region: R. **Zeiller.** Three illustrations of the fossil are given.—The direct hydrogenation of some aromatic diones: Paul **Sabatier** and A. **Mailhe.** The direct hydrogenation by means of reduced nickel of the aromatic diones gives results corresponding to the ordinary hydrogenation of these ketones, aromatic hydrocarbons being formed. Benzil and benzoin gave symmetrical diphenylethane. Benzoylpropanone gave principally butylbenzene.—The visibility of Saturn's ring at the present time: J. **Guillaume.** An account of the appearance of the ring on the night of November 23. The results confirm the observations of W. C. Bond and of Secchi.—The Giacobini comet 1907*a*: MM. **Giacobini** and **Javelle.** Observations of the position of the comet were taken on December 4, 6, and 7. The comet had a stellar appearance of about 15″ diameter, and showed a nucleus of the fourteenth magnitude.—Observation of the transit of Mercury of November 14 made at the Fabra Observatory at Barcelona: J. Comas **Solá.** The conditions of observation were good. The times of the second, third, and fourth contacts are given. The mean of five observations of the equatorial diameter was 8″·94, the form of the planet being sensibly circular.—Certain ruled surfaces: M. **Tzitzéica.**—The permutation of the integrals of a system of differential equations: A. **Buhl.**—The function $D(\lambda)$ of Fredholm: T. **Lalesco.**—The systems of partial differential equations leading to (1) the study of the finite deformations of a continuous medium in space of n dimensions; (2) the determination of the systems of orthogonal curvilinear coordinates with n variables: M. **Riquier.**—General mechanics: Eugène and François **Cosserat.**—An electromagnetic compass particularly suitable for armoured blockhouses and submarines: Louis **Dunoyer.** The transmitting compass is placed in a part of the ship where the field gives no trouble, or may be compensated, the readings being transmitted by the arrangement described to the receiver, from which the ship is steered.—The number of free electrons of metals and the electromotive series: V. **Schaffers.**—The condensation of water vapour in the presence of the radium emanation: Mme. **Curie.** Moist air containing the radium emanation always contains a fine fog more or less opaque, and formed of very fine particles. A very much smaller amount of water vapour than that required for saturation is sufficient to produce this phenomenon, but it is not produced when the air is perfectly dry. This effect is quite separate from the known phenomenon of condensation of water vapour by gaseous ions.—The lithium contained in radio-active minerals: Mlle. **Gleditsch.** In view of the observation of Sir William Ramsay that radium transforms copper into lithium, it appeared of interest to see if minerals which contain both copper and radium also contain lithium. In agreement with the result of McCoy (NATURE, November 28), Joachimsthal pitchblende has been found to contain a minute amount of lithium.—Singing flames and tubes with flames of several notes: M. **Athanasiadis.** Experiments are described showing that a manometric flame can produce a perceptible sound, the number of vibrations of which is equal to the number of vibrations of the manometric membrane. A manometric flame can also produce simultaneously two or more notes.—The use of very low temperatures for spectrum analysis and for the study of magneto-optic phenomena in solutions: Jean **Becquerel.**—The propagation of telephone currents through subterranean lines: Henri **Abraham** and M. **Devaux-Charbonnel.** Underground telephone lines are only available for very moderate distances; the pitch of the notes exercises a considerable influence on the power of transmission to large distances, low voices being better transmitted than high ones, as the line absorbs the high harmonics.—The saturation intensity of magnetisation of iron and nickel: Pierre **Weiss.**—The application of the law of Poiseuille to the measurement of high pressures: A. **Perot.** The volume of water forced through a very fine capillary tube, applying Poiseuille's law, has been used as a basis of a manometer for high pressures, 300 kg. per sq. cm. The accuracy was found to be about 0·5 per cent.—The use of heavy hydrocarbons for lighting: Louis **Denayrouze.**—The action of an incandescent electric conductor on the gases which surround it: M. **Couriot** and Jean **Meunier.** An explanation is put forward of the cause of the non-inflammation of certain explosive mixtures of oxygen and hydrocarbons by means of a wire carried to incandescence by electricity. It is assumed that the wire repels the oxygen molecules and attracts those of the hydrocarbon, so that the actual composition of the gaseous zone immediately round the wire is not in explosive proportions.—The method of limiting densities and its application to the atomic weight of nitrogen: Ph. A. **Guye.** An answer to some criticisms of M. Daniel Berthelot. The author prefers to base his calculations on the idea of corresponding states rather than on that of limiting densities, and compares the two methods in detail as applied to the experimental ratios $N_2O : O$, $N_2O : N_2$, $N_2 : O$, $NO : O$, $NO : N$, and $N : O$. These lead to a mean valu

for the atomic weight of nitrogen of 14·010 instead of the 14·005 of M. Berthelot.—The non-existence of a common solvent for white and red phosphorus: Alb. **Colson.** The author has been unable to dissolve red phosphorus in essence of turpentine, and there seems to be no solvent known which will dissolve both varieties.—The equilibrium of the nickel-bismuth system: A. **Portevin.** The state of equilibrium is only attained for alloys of the pure metals.—An apparatus designed for the production of spark spectra of solutions: A. **de Gramont.** In the apparatus, a drawing of which is given, the spark is produced between two drops of the liquid held up in capillary tubes of fused quartz. The spectra are free from the lines of platinum and silicon.—The identity of graphite and the graphitic carbon set free from castings during tempering: Georges **Charpy.** The experiments described lead to the conclusion, contrary to the views of Forquignon and of Wust and Geiger, that these two forms of carbon are the same.—The action of phosphorus trihydride on mercuric chloride and bromide: P. **Lemoult.**—Carbon monoxide in coal gas: Léo **Vignon.** The larger the amount of oxygen in the coal the larger is the proportion of carbon monoxide and dioxide in the gas obtained from it. At a temperature of 900° C., rather less than one-third of the oxygen of the coal is found in the gas in the form of these two oxides.—The transformation of barbaloin into an isomeric aloin; β-barbaloin and the existence of the latter in several kinds of aloes: E. **Léger.**—The dissociation of combinations of colouring acids to basic colours by adsorbing substances: L. **Pelet-Jolivet.**—Sparteine. The isomerisation of α-methyl-sparteine: Charles **Moureu** and Amand **Valeur.**—The synthesis of symmetrical phenylated anilidophenosafranine: Ph. **Barbier** and P. **Sisley.**—The deposit of evergreen copper: Étienne A. **Ritter.**—The occurrence of granite in the diamond-bearing chimney of De Beers: L. **De Launay.** Some time ago the author predicted that granite would be encountered in a boring at Kimberley at a depth of about 600 metres, and his views have been confirmed by the discovery of granite in this chimney at a depth of 641 metres.—Remarks on the affinities of the Malpighiaceæ of Madagascar, concerning the new genus Tricomariopsis: Marcel **Dubard.**—The variations of dry weight in the higher plants under different luminous intensities: W. **Lubimenko.**—The influence of the hygrometric state of the air on the preservation of seeds: E. **Demoussy.** When the hygrometric state, at 25° C., is above 0·7, many seeds rapidly perish, the seeds of the Cruciferæ being the most resistant.—The inosites from Gui: Georges **Tanret.**—A colour reaction for use with fungi: L. **Arnould** and A. **Goris.**—The fatigue of earth: I. **Pouget** and D. **Chouchak.**—Two hybrids of the peacock and Cochin China fowl: G. **Prys-Mellier** and E. **Trouessart.**—Histolysis of the muscles after the nuptial flight in ants: Charles **Janet.**—The periodic variations of sign of phototropism in *Clibanarius misanthropus*: Mlle. Anna **Drzewina.**—The action of the ichthyotoxins on the nervous system of animals immunised against these substances. Contribution to the study of immunity: E. **Gley.**—The favourable influence of small doses of zinc on the vegetation of *Sterigmatocystis nigra*: Maurice **Javillier.**—The presence of phosphorus in the fatty material of micro-organisms: E. **Axilaire.**—The conditions of hydrolysis of the protoplasmids: A. **Étard** and A. **Vila.**—The effects of light on the vision: Jules **Amar.** Excluding pathological conditions, an excess of light puts the eyes into a bad condition for their normal working.—The influence of the illumination round the observer on the acuteness of vision for night signals in navigation: André **Broca** and M. **Polack.**—The presence of yeasts in the fatty bodies of several Coccideæ: A. **Conte** and L. **Gaucheron.**—The trypanolytic property of the serum in experimental nagana: A. **Ridet** and G. **Vallet.**—The pathogeny of glaucoma: A. **Terson.**—The death of infants by the thymus and in chloroform anæsthesia. Anatomical, physiological, and clinical study: R. **Robinson.**—The action of chlorine on the tubercle bacillus: MM. **Moussu** and **Goupil.**—The presence of the Trias in the mountains of Gigondas (Vaucluse), and the phenomena of *charriage* which are observed in this *massif*: L. **Joleaud.**—The Neocretacean of Argolide: Ph. **Négris** and Const. A. **Ktenas.**—The discovery of vertebrates in the Oligocene of Fronsadais, basin of the Gironde: G. **Vasseur.**—Some new fossil plants in the Sparnacean of the Paris region: P. H. **Fritel.**—Study of a specimen taken from the sea bottom of the Channel near the coast: J. **Thoulet.**

CALCUTTA.

Asiatic Society of Bengal, November 6.—Note on the common English merlin (*Æsalon regulus*) and its training: Lieut.-Colonel D. C. **Phillott.**—A case of lateral floral proliferation of the inflorescence of the pine-apple—*Ananas sativus*, Schult. f.: Captain A. T. **Gage.** Descriptions with figures of a pine-apple surrounded by many small elongated pine-apples after the manner of a hen-and-chickens daisy.

DIARY OF SOCIETIES.

THURSDAY, DECEMBER 19.

CHEMICAL SOCIETY, at 8.30.—Derivatives of Tetramethyl Glucose: J. C. Irvine and A. M. Moodie.—The Characterisation of Mercerised Cotton; Preliminary Note: J. Hübner.—Attempted Synthesis of β–N–β / β–CH–β Di-naphthacridine; Condensation of Methylene Dichloride and 1-Substituted-2-Naphthylamines: A. Senier and P. C. Austin.

LINNEAN SOCIETY, at 8.—On Mendelism and Sex: Dr. Archdall Reid.

INSTITUTION OF MINING AND METALLURGY, at 8.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Electrical Power in Railway Goods Warehouses: H. Henderson.

FRIDAY, DECEMBER 20.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Mechanical and Therma Efficiency of a Petrol Engine: L. G. E. Morse.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Notes on the Manufacture and Upkeep of Milling Cutters: Dr. H. T. Ashton.

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