THURSDAY, NOVEMBER 14, 1912.

ELECTRONS AND THE ELECTRO-MAGNETIC FIELD.

Electromagnetic Radiation and the Mechanical Reactions arising from it. Being an Adams Prize Essay in the University of Cambridge. By Dr. G. A. Schott. Pp. xxii + 330. (Cambridge: University Press, 1912.) Price 18*s.* net.

PROF. SCHOTT'S original essay is, in this book, supplemented by a series of valuable appendices, which amply justify the delay in its publication. The work is deductive in plan; its foundations are the electromagnetic equations of Maxwell and Hertz, together with the Larmor-Lorentz expression for the mechanical force on a moving charge. The "retarded potentials" of the electromagnetic field are transformed so as to yield Schott's solutions, in the form of "modified Fourier integrals," and most of the calculations are performed from these as starting point. They lead simply, and with considerable mathematical rigour, to many results obtained by other writers; in particular, the "point laws" of Liénard and Wiechert are deduced, and are used to illustrate the general features of the electromagnetic field in a number of special cases. The exact calculations, however, are more readily executed with Schott's expressions, and various simple cases of motion of electrons are thus dealt with, as, *e.g.*, uniform or uniformly accelerated rectilinear motion. Periodic motions, such as uniform circular motion of a single electron, or of a ring of electrons, are also discussed. More complex cases, like pseudo-periodic or aperiodic motions, cannot be solved completely, but the distant field is approximated to. Specially interesting are the problems relating to the pulse theory of the X-rays, and the precessional motion of a ring of electrons, as applied to Ritz's theory of the Zeeman effect.

The velocities of the electrons are not restricted to be less than the velocity of light, chiefly because the mathematical expressions require no such condition (though the work is far simpler in the restricted case). It is pointed out that no experimental evidence, either way, has been brought to settle the question of the possibility of velocities exceeding that of light; if the Lorentz mass-formula were universally true, indeed, the question would be decided in the negative, but this formula has been verified (by Bucherer) only for velocities considerably less than that of light. Moreover, the theory of relativity, which is based on this formula and has proved useful in explaining aberration phenomena and the behaviour of moving optical systems, neglects the loss of energy by radiation from accelerated charges; this, however, becomes very important for velocities approaching that of light.

In the appendices several theorems are proved which lead up to an interesting discussion of the possible mechanical explanations of the electron. It is shown that the Lorentz deformable electron is more easily explained mechanically than the electrons of Abraham and others, as it only requires an invariable hydrostatic pressure of the æther over its surface to enable it to subsist. This pressure is estimated (p. 269) as 10^{25} atmospheres. Moreover, the mass-formula for such an electron is practically the only one which can be applied in the mathematical theory of the mechanical forces and the radiation.

For the mathematician the book abounds in problems and suggestions of interest and importance; especially does it clearly display the need for the cooperation of the pure analyst in the study of the summation and convergence of the difficult series and integrals which occur in its investigations. The physicist will, perhaps, find it rather tedious to unearth the physical conclusions (which are pointed out from time to time in the course of the work) from the mass of complicated mathematics in which these remarks are involved. The great value of the book would have been increased if the physical bearing of the results had been summarised in an extra chapter; this is done to a slight extent in the preface. A greater number of numerical calculations would also have been advantageous in giving a clearer grasp of the results, but the great labour required for such an undertaking sufficiently explains the omission.

THE LAND AND ITS LORE.

(1) *Common Land and Inclosure.* By Prof. E. C. K. Gonner. Pp. xxx + 461 + 5 maps. (London: Macmillan and Co., Ltd., 1912.) Price 12*s.* net.

(2) *Byways in British Archaeology.* By Walter Johnson. Pp. xii + 529. (Cambridge: University Press, 1912.) Price 10*s.* 6*d.* net.

(1) SCIENTIFIC studies of the history of land-holding have a peculiar importance at the present moment, when legislative innovations in ownership are so widely mooted on *a priori* grounds. By supplying valid inductions from the past, science here, as in other spheres, provides the statesman with a solid foundation for political principles, and a sure test for fallacious schemes.

The entire history of English agriculture, so far as it is connected with national progress and advance in civilisation, is bound up with "common" and inclosure, and the passage from the

former to the latter. The land question, it is not too much to say, cannot be begun to be understood until this relation has been worked out.

"Common" in early times was "in entire contrast to the ideas associated with it in the present day. . . . Its existence now is taken as denoting the claims, somewhat vague and precarious, of the public as against those holding the land and engaged in its cultivation. But this finds no sanction in a time when . . . common was a result of a claim to land, and formed a necessary condition of its proper management. . . . The early rights of common were anything . . . rather than a general claim on the part of the public. . . . The common right was an essential part of agriculture, and it was only as, owing to changes in circumstances, this became less apparent, that casual profits and gains and the so-called rights of the poor, these latter being in many instances a trespass and not a right, came to be important."

Thus Prof. Gonner defines his subject. The history of the method of common and of the gradual progress of inclosure occupies two-thirds of the volume. The rest is devoted to the effects of the evolutionary change. Inclosure is part of "a wider economic movement." Its "beneficial effect on farming is undoubted . . . particularly in the increased utilisation of what is, after all, the distinctive agricultural wealth of England, rich grazing and dairy lands." Of particular importance is its connection with "the change whereby agriculture, from being a means of subsistence to particular families, had become a source of wealth to the nation." It is particularly interesting to the sociologist to note that rural population "did not vary with inclosure, and that this movement was not, at any rate, the main cause of the increase in poor relief expenditure."

Prof. Gonner has written an invaluable study, which is final, and should become a classic. No sociologist and no statesman can afford to ignore it.

(2) The author of "Folk Memory" devotes 400 pages to answering the question: In what ways may the church-fabric be regarded as the social centre of early English life? There is abundance of original observation, and in controverted matters, such as round towers, the author's judgment is eminently reasonable. For he treats these radiating paths of folklore—they are this rather than byways—from a wide sociological outlook. In "The Folklore of the Cardinal Points," and "The Labour'd Ox," he treats new ground. "The Cult of the Horse" is an interesting compilation of palæontological data and early English horse-lore. The "White Horse," and what amounts still to a tabu against eating horseflesh, receive illumination. Mr. Johnson believes that folk-memory is on the wane, since "the printed book and the daily newspaper . . . remove the need for its lawful exercise." It would be more scientific, perhaps, to regard the ultra-popular reactions to these modern influences as being themselves a new stage of folk-thinking and folk-memory.

A. E. CRAWLEY.

ENGINEERING HANDBOOKS.

(1) *Reference Book for Statical Calculations (Rapid Statics), Force-diagrams for Frameworks, Tables, Instructions for Statical Calculations, &c., for all Classes of Building and Engineering.* By Francis Ruff. Pp. 136; illustrated. Vol. i. (London: Constable and Co., Ltd., 1912.) Price 4*s.* net.

(2) *Les Nomogrammes de l'Ingénieur.* By Ricardo Seco de la Garza. Avec une Préface de Maurice d'Ocagne. Pp. xii + 195 + 85 plates. (Paris: Gauthier-Villars, 1912.) Price 12 francs.

(3) *Laboratory Instruction Sheets in Elementary Applied Mechanics.* By Prof. A. Morley and W. Inchley. Pp. v + 50. (London: Longmans, Green and Co., 1912.) Price 1*s.* 3*d.* net.

(4) *A Handbook on the Gas Engine.* Comprising a Practical Treatise on Internal Combustion Engines. By Herman Halder. Translated from the German and Edited by W. M. Huskisson. Pp. xii + 317. (London: Crosby Lockwood and Son, 1911.) Price 18*s.* net.

(5) *Concrete Costs.* Tables and Recommendations for Estimating the Time and Cost of Labour Operations in Concrete Constructions and for Introducing Economical Methods of Management. By Dr. Frederick W. Taylor and Stanford E. Thompson. First edition. Pp. xxii + 709. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1912.) Price 21*s.* net.

(1) THE usual graphical methods for determining the stresses in framed structures form the subject of this little book. With the exceptions of the wind pressure on roof trusses, the load on a framework column, and pressure upon retaining walls, the structures are subjected to symmetrical loads concentrated at the joints. Each form of roof, bridge truss, girder, or cantilever occupies a separate page, together with its reciprocal figure, the construction of the force polygons being described on the opposite sheet. There are some thirty examples of the usual forms of truss, covering the ordinary cases that occur in engineering practice. The method adopted of forming the reciprocal figures loses much by the notation employed, and is far less satisfactory

than Bow's notation, in which the spaces between the members of a structure are designated by a letter or numeral. The concluding third of the book contains a short dissertation on reinforced concrete (in which the ratio of the moduli of elasticity of steel to concrete is taken at the low value of 10), and this is followed by tables usually found in engineers' handbooks on the geometrical properties of structural shapes, such as moments of inertia. There are many blemishes due to imperfect translation, and we find such expressions as "10-fold security" for "factor of safety of ten." The translation does not extend to weights and measures, which are in the metric system.

(2) The preface to this volume is, for the most part, a reprint of remarks made by M. Maurice d'Ocagne, Ingénieur en chef des Ponts et Chaussées, at the Fourth International Congress of Mathematicians, in Rome, 1908. In this paper he defines the word "nomogramme," which is probably new to most English mathematicians, the nearest English equivalent being an abacus, known as an instrument for performing calculations by balls sliding on wires, which are still employed in Russia, China, and Japan. M. d'Ocagne has brought forward this system of graphical calculation by published researches extending over twenty-five years, and the author of this work employs the method for solving problems in military engineering, though many of the examples are of wider application, and are of extended use in the solution of equations of three or four (or more) variables. The interest in the work would therefore lie chiefly in the method as such, the particular applications of the method to the solution of equations used by the military engineer being of secondary importance, though, as a handbook for rapid calculation within the limits of the chosen field of utility, it would certainly serve a useful purpose to many. The reader will doubtless find himself constructing nomogrammes to suit particular problems of his own, and thus the work before us is extremely suggestive, and a fruitful stimulus to the use of a graphical method of varied application.

There are eighty-five nomogrammes in the work, each on a separate sheet and consisting for the most part of straight lines upon which divisions are marked. A loose celluloid sheet marked off in rectangular coordinates is provided for laying upon the nomogramme, and upon placing it in such a position that the known values of the variables in the equation are cut by the lines, the value of the unknown variable may be ascertained by intersection upon the scale provided for that variable. Thus, for example, the solution of plane triangles may be taken as being a problem of general application. Given the two sides and included angle, the opposite side (a) may be found directly by the application of the rectangular coordinates to the nomogramme; in other words, the equation $a^2=b^2+c^2-2ab\cos A$ may be solved for all values of b, c and A. Besides the usual problems in mensuration, the safe loads on columns for given values of the ratio of length to least radius of gyration for various materials, the bending of beams, stresses in roof trusses and bridges and numerous other problems may be solved without calculation. The printing of the scales on the nomogrammes leaves much to be desired, but the work as a whole is a most interesting contribution to graphical methods of solution.

(3) This little book is made up of twenty-five single perforated sheets bearing upon each a concise description of a simple laboratory experiment in applied mechanics with an illustration of the apparatus. The experiments are of the usual kind for the elementary mechanical laboratory and comprise statics, efficiency of lifting machines and friction, forces in braced structures, moduli of elasticity, spring vibrations, pendulum, and others. Prof. Morley states that they are selected from instruction sheets used in his laboratory, and may be usefully employed in conjunction with his textbooks on elementary applied mechanics. However opinions may differ concerning the expediency of giving a student cut-and-dried directions concerning his laboratory work and leaving little to his own judgment and talent, those who favour this plan of instruction will find all that they desire in these well-arranged experiments. It saves much time and needless explanation on the part of the demonstrator to have the experiments written out, and as these are selected by experienced teachers they should prove useful in the elementary laboratory.

(4) This work contains a mass of constructional detail on the gas engine which should find favour with engineers and draughtsmen engaged in the design of such motors. It represents the results of much practical experience, and on the part of both the author and translator it shows a very careful scrutiny of the best engineering practice. The thermodynamics of the subject is somewhat neglected, but this omission is counterbalanced by the exhaustive treatment of the forces developed by the engine when running. The effect of the inertia of the reciprocating parts, turning moment diagrams for calculating fly-wheel masses, and balancing, are discussed with the view of assisting the draughtsman in his design, and the effects of various combinations of cylinders receive more attention than usual in works of this kind. Minute details are set forth with painstaking care, and

there is no part of the anatomy of the engine which has not a place in the work. Metric measures have been converted by the translator, but the tabulated dimensions of Continental engines have been retained in millimetres in parallel columns.

(5) The cost of mixing and laying concrete is essentially governed by local circumstances, and it would be unsafe to generalise from isolated results, however carefully they may have been collected. The authors have been at great pains to collect information based upon work done in the United States, and no doubt with due allowance for the difference in the cost of labour and materials and the varying rate of output of work, much of their conclusions would be applicable to other conditions and places. But the work is not wholly confined to questions of cost, for it contains much valuable, if incidental, information concerning the making of concrete in bulk, form of moulds, reinforcement for ferro-concrete and other matters pertaining to construction in this material. It is to be regretted that so much prominence was given to costs, though the title of the work very clearly points to this as the dominant feature. Nevertheless, with due allowances, as a reference book there is much in it for the architect and engineer, and it is eminently satisfying to know that the figures were obtained by close application and systematic study of construction work for many years.

OUR BOOKSHELF.

Manual Training Woodwork Exercises Treated Mathematically. A Scheme for Linking up Practical Mathematics with Woodwork; including a Complete Course of Mensuration. By F. E. Drury. Pp. xi+215. (London: G. Bell and Sons, Ltd., 1912.) Price 2*s.* 6*d.*

As is indicated by the title, the author's object in preparing this volume has been to show how practical mathematics may be linked up with woodwork in the form of mensuration, &c. The book is intended for use in preparatory day trade schools, some secondary schools, and in evening continuation and technical courses of an elementary character. It is stated that the work of calculation is intended to be an application of the principles received in lecture and experimental classes, but it will be seen that these may, in a large measure, be imparted by the woodwork teacher if he has a generous allowance of time. With this end in view, the book contains a very good systematic course in mensuration, elementary algebra, and the construction and properties of simple graphs; the application of these principles to the course of woodwork exercises provided is clear and good, and the book should be very useful to manual instructors who are expected to train boys both in practical mathematics and woodwork.

As to the desirability of adopting this course there may be difference of opinion, especially with reference to evening schools, where the time permitted for actual work in the wood shop is very limited. Any reason which may be advanced for bracketing together woodwork and mathematics may equally well be applied to other branches of practice, with a consequent multiplication of the number of classes in practical mathematics carried on in the same building, each no doubt selecting those portions which appear to suit the particular trade involved. It is fairly obvious that such a plan—already adopted in some institutions—cannot fail ultimately to lower mathematical standards. The author has been successful in carrying out his views in the book, and, if it be regarded as a further means of interesting students in the woodwork shop in their work in classes under the supervision of mathematical teachers, it can be highly commended. The woodwork examples are good, and the book is well and clearly illustrated.

Compendio Elemental de Zoología. By Ángel Gallardo. Pp. 360. (Buenos Aires: Ángel Estrada y Cia, 1912.)

Prof. Ángel Gallardo has prepared a useful elementary text-book of zoology, specially adapted for the Argentine Republic. After an introduction contrasting organisms and inorganic things, comparing plants and animals, describing cells and tissues, and the early stages of development, discussing the factors of evolution and other generalities, the author passes to a rapid survey of the animal kingdom. The book is very clearly and tersely written, with numerous illustrations, for the most part admirable. In the classification adopted, "Tipo vii., Lofostomas," includes the three classes—Rotifers, Bryozoa, and Brachiopods—characterised by the tentacular apparatus at the mouth. Still more doubtful is "Tipo viii., Gusanos," which includes Annelids and Plathelminthes, characterised by having trochosphere larvæ.

Twelve Moons. By Frances A. Bardswell. Pp. 90. (London: Elkin Mathews, 1912.) Price 2*s.* 6*d.* net.

In twelve short sections devoted to the respective months of the year, the author expresses pretty sentiments upon the changing beauties of the countryside. She loves the poetry of nature; and her words will awaken sympathetic response in readers who are content to contemplate the surface of things. The old proverb "February Fill-dyke" leads her to say: "To brim the ponds and flood the waterways is the mission of the month." As a matter of fact, the average rainfall of February in England as a whole is less than that of either January, August, October, November or December, though there are local differences. Possibly the explanation of the proverb is not that "deluges of rain" actually fall in February, but that the water-courses begin to fill up during that month as the result of the rise of the water-table due to the rainfall of preceding months.

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.*]

Radium and Earth History.

IT would appear that radium has landed geologists and biologists in a difficulty greater than that from which it was hoped it would deliver them. There is radium in the earth, and radium in disintegrating gives out heat. Therefore a once molten globe will cool down more slowly than if it contained no such independent source of heat. Lord Kelvin's calculations were made on the supposition that there was no source of heat except what the earth possessed as a molten globe. Hence we are at liberty to extend the time that has elapsed since the earth became the possible theatre of geological change to 500,000,000, 1,000,000,000, or even more, years ago. Radium has given us a blank cheque on the bank of time.

So far so good. But when the actual calculations were made as to how much the radium known to exist in the outer shell of the earth would effect its cooling, this was found to be too great. It would, in fact, *raise* the temperature of the earth the fraction of a degree annually.

Two suggestions in the way of explaining the difficulty have been made by Prof. Joly in his "Radioactivity and Geology." We do not think that either will bear the test of careful examination.

It is only the outer shell of the earth that can be examined for radium, and though there appears to be no diminution with depth, there may be less, or none, in the lower parts. If, then, we have to spread the heating effects of the radium of the outer shell over the whole earth, it will obviously be insufficient to raise its temperature. The only possible result of its disintegration will be a retardation of its cooling to an indefinite extent, which is what is wanted. This is the first suggestion.

The second, admitting that the proportion of radium in the interior may be the same as at the surface, avails itself of the fact that vast masses of the central earth may be thermally isolated for immense periods of time. The rise in temperature of such parts—due to their radium—need not, then, affect the rocky crust. In the course of prolonged ages, however, such internal reservoirs of heat might, so to speak, overflow. Great rushes of heat might reduce the outer shell to a molten state, and inaugurate a new geological era. To quote Prof. Joly:—

"With an interest almost amounting to anxiety, geologists will watch the development of researches which may result in timing the strata and the phases of evolutionary advance; and may even—going still further back—give us reason to see in the discrepancy between denudation and radio-active methods, glimpses of past æons, beyond that day of regeneration which at once ushered in our era of life, and, for all that went before, was 'a sleep and a forgetting.'"

But let us look at these interesting suggestions a little more closely. If the radium contents of the outer shell were spent in heating the whole earth—or any considerable portion of it beyond the shell containing it—then we might suppose it just sufficient to retard its cooling indefinitely. But as the temperature of the earth increases with depth, we cannot suppose that any of the radium-generated heat of the outer shell passes downwards. It must *all* be spent in heating its *own mass*. Therefore, according to calculation, this outer shell should be rising in temperature. There seems to be no escape from this conclusion. And this applies also—and even more forcibly—to the second explanation. For with an interior rising in temperature it is still more difficult to imagine any of the radium-generated heat of the outer shell passing downwards. The radium heat of the crust must all be spent on itself.

Even this does not express the full extent of the difficulty. The theory of the radio-active elements is that they have their periods in which they lose half their substance. The period of radium is 1760 years, and that of uranium 5,000,000,000 years. Now, since we know of no source whereby the supply of uranium in the earth is replenished, we must suppose that there was twice as much uranium 5000 million years ago as there is to-day. And whatever length of time we go back we must suppose there was more uranium, and hence a greater heating effect, than there is to-day. A molten globe could not *begin* to cool until the radium contents of its outer shell were *less* than that of the earth to-day.

The moon presents another difficulty. Our satellite is generally held to be a bit of the earth thrown off some fifty-six million years ago. It was then molten, and the drag of the tides produced in its molten mass by the earth gradually reduced its rate of rotation. Now it only turns once on its axis in the course of a revolution round the earth. The moon's radium has not prevented it reaching a stage of cooling far beyond that of the earth. And yet the moon may be supposed to have had the full proportion of radium known to exist in the outer shell of the earth. Yet it has cooled down from a molten state in fifty-six million years in spite of its radium! And it would appear that the earth has done the same, although it has not reached the same stage. For if the moon was molten when it began its separate existence, so must the earth—which gave it birth—have been.

And it would appear that there must be *more* radium in the sun than in the earth. For helium, the product of the disintegration of radium, was discovered spectroscopically in the sun years before it was known on earth. It must surely, therefore, exist there in much larger quantities. Hence the sun should be getting hotter at a greater rate than the earth.

The difficulties introduced by radium into earth history are greater than that which it was hoped it would remove. G. W. BULMAN.

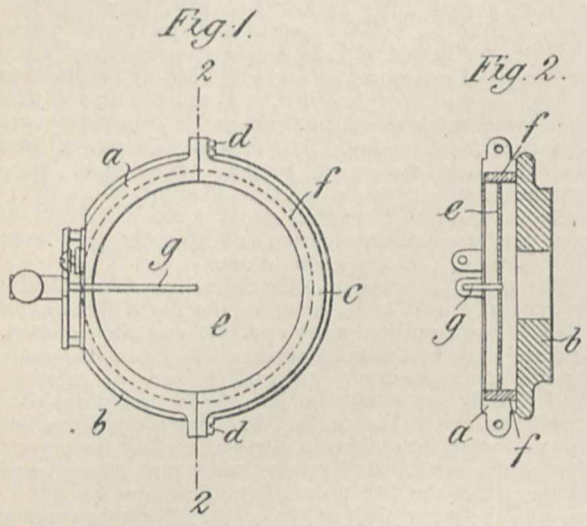
The Moon and Poisonous Fish.

MAY I ask for a little space in your columns to inquire if any of your readers can give any information as to the origin of a belief, very widespread in South Africa, that fish exposed to the influence of moonlight becomes poisonous? I have not yet attempted any experiments to test the truth of the statement, nor have I been able to obtain actual evidence of illness or death following the eating of such fish. The belief is very firmly rooted here among all classes of persons, but no one seems able to say how or when it originated, or on what grounds it is based. One very trustworthy witness told me that he had accidentally left some fresh fish out in the moonlight one night, and that it was quite bad in the morning; he admitted, however, that the closeness of the atmosphere might have occasioned the effect, and, of course, he did not divide the sample so as to keep part of it unexposed. I intend to test the statement experimentally when opportunity offers; meanwhile possibly some of your readers can say whether the belief in this ill-effect of moonlight is found in other localities. E. G. BRYANT.

Grey Institute, Port Elizabeth, Cape Colony,
October 7.

Gramophone Experiments.

FOR some time I have been experimenting with the gramophone sound-box, and I came to the conclusion that with a diaphragm nipped firmly between two rubber rings there was a tendency for a vibration from the stylus bar to be cannoned back from the edge so held, and that one did not get a true ring. I made a sound-box as shown below (Figs. 1 and 2) in



FIGS. 1 and 2.—*a* is half a split ring connected to the sound box *b*; *c* is the other half of the split ring connected to *a* by screws *d d*; the diaphragm *e* is held in position by an elastic ring *f*, which is secured to sound box by means of the two halves *a* and *c*; *g* is the stylus bar. The sound box is protected by patent.

which the diaphragm is only held on its edge, and by cutting the front of the box in half it enabled me to mount the diaphragm free from distortion. With this box there is a very marked difference.

In a band record one can differentiate each instrument more readily.

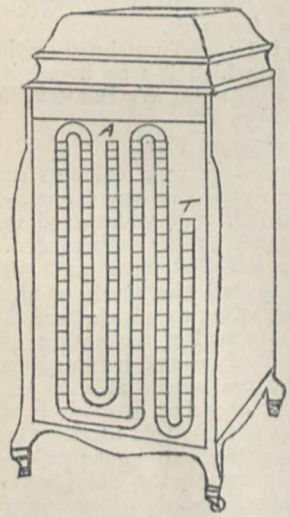


FIG. 3.—*A* connected with tapered arm: *T* with horn.

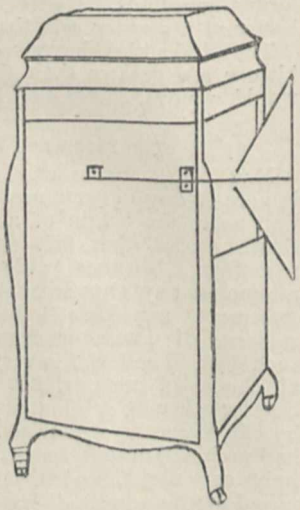


FIG. 4.—Showing position of conical reflector.

Working on Prof. McKendrick's experiments, as described in NATURE of April 20, 1911, I found that with an enclosed horn machine, as shown in Figs. 3 and 4, by passing the sound waves through about 17 ft. of 2-in. flexible metallic voice tube (the tubes all being inside the cabinet out of sight), all the noises which he eliminates by the use of peas are done away with, and the sound much increased by not using peas. In addition to this, to augment the sound I place a 2 ft. by 8 in. deep conical reflector with the apex of the cone cut off, leaving a 4-in. opening pointing to horn, as shown in Fig. 4. The result is that a musical effect is produced free from overtones and harsh sounds. ERNEST DE LA RUE.

WITH reference to the above interesting communication by Mr. Ernest de la Rue, I have to say that the method he has adopted for fixing the diaphragm of the sound-box is a marked improvement. Mr. de la Rue has kindly sent me a specimen of the sound-box, and it has given me great satisfaction, both as to quality and volume of tone. I have not had the opportunity of hearing the arrangement he has devised for removing friction noises, but no doubt it will be satisfactory. I am quite pleased with my own method, which gives excellent results, and it is adapted to the older form of gramophone which I use. The tones are sufficiently loud for a room of ordinary dimensions, and the quality, with Mr. de la Rue's sound-box, is excellent. A witty friend of mine has called my plan the pipe of peace (peas)! J. G. MCKENDRICK.

Reported Occurrence of the Dartford Warbler at the Tuskar Light Station.

I HAVE recently returned after nine weeks' residence at the Tuskar Light Station, off the south-east coast of county Wexford, where I have been prosecuting the study of bird-migration. I obtained several interesting records, including those of some rare species. To these may be added a highly interesting and at the same time important record of the occurrence of a Dartford warbler. Owing to the sedentary habits of this species its appearance at the Tuskar Rock was quite unexpected, and heretofore the bird was unknown in Ireland.

This warbler was obtained on October 27, as I am informed by the principal lightkeeper, to whom I owe my cordial thanks for the kind aid he has so often and cheerfully given me in connection with my work on bird-migration. C. J. PATTEN.

The University, Sheffield, November 10.

THE CRYSTAL SPACE-LATTICE REVEALED BY RÖNTGEN RAYS.

DURING a visit to Munich at the beginning of August last the writer was deeply interested in some extraordinary photographs which were shown to him by Prof. von Groth, the *doyen* of the crystallographic world, and professor of mineralogy at the university of that city. They had been obtained by Dr. M. Laue, assisted in the experiments by Herren W. Friedrich and P. Knipping, in the laboratory of Prof. A. Sommerfeld in Munich, by passing a narrow cylindrical beam of Röntgen rays through a crystal of zinc blende, the cubic form of naturally occurring sulphide of zinc, and receiving the transmitted rays upon a photographic plate. They consisted of black spots arranged in a geometrical pattern, in which a square predominated, exactly in accordance with the holohedral cubic symmetry of the space-lattice attributed by crystallographers to zinc blende.

Prof. von Groth expressed the opinion, in agreement with Herr Laue, that owing to the exceed-

ingly short wave length of the Röntgen rays (assuming them to be of electromagnetic wave character), they had been able to penetrate the crystal structure and to form an interference (diffraction) photograph of the Bravais space-

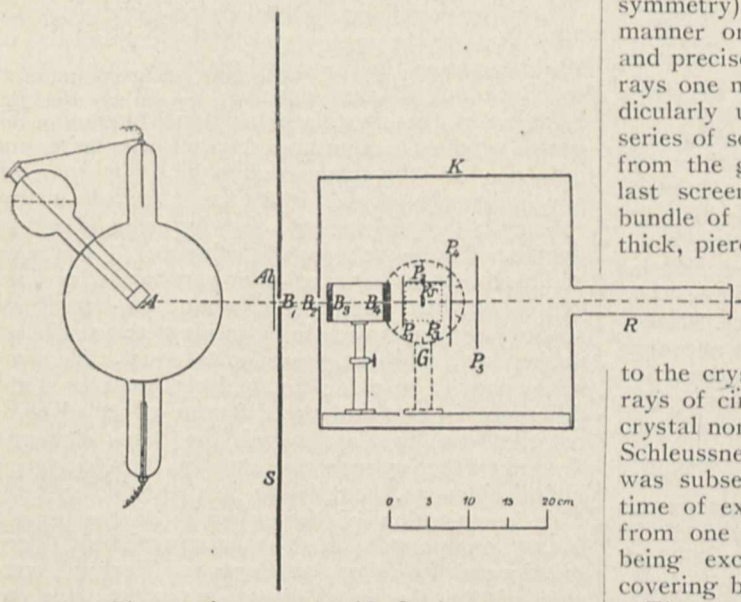


FIG. 1.—Diagrammatic representation of Dr. Laue's apparatus.

lattice. This latter is the structural foundation of the more complicated regular point-system according to which the crystal is homogeneously built up, and the points of which (the point-system) represent the chemical elementary atoms. The space-lattice, in fact, was conceived to play the same function with the short-wave Röntgen rays that the diffraction grating does to the longer electromagnetic waves of light.

The details of this work were laid before the Bavarian Academy of Sciences at Munich in two memoirs, on June 8 and July 6 last, and the two memoirs are now duly published in the *Sitzungsberichte* of the Academy.[1] Besides a diagram of the apparatus, which is reproduced in Fig. 1, they are illustrated by reproductions of a dozen of these photographs, one of which is also reproduced in Fig. 2. There can be no doubt that they are of supreme interest, and that they do in reality afford a visual proof of the modern theory of crystal structure built up by the combined labours of Bravais, Sohncke, Schönflies, von Fedorow, and Barlow. Moreover, they emphasise in a remarkable manner the importance of the space-lattice, so strongly insisted on from theoretical considerations by Bravais, Lord Kelvin, and von Groth, and from experimental considerations by Miers and the writer. They further confirm the structure assigned to this binary compound zinc sulphide, ZnS, by Pope and Barlow. Incidentally they may form a crucial test of the accuracy of the two rival theories now being discussed as to the nature of X-rays, the corpuscular and the wave theory.

[1] *Sitzungsber. der Kön. Bayerischen Akad. der Wiss., Math. Phys. Kl.*, 1912, 303 and 363.

Out of an excellent crystal of zinc blende a plate was cut a centimetre square and half a millimetre thick, parallel to a cube face (100), that is, perpendicular to one of the principal cubic crystallographic axes of the crystal (a tetragonal axis of symmetry). The plate was supported in the usual manner on the crystal holder of a goniometer, and precisely adjusted so that a beam of Röntgen rays one millimetre in diameter impinged perpendicularly upon it, after passing first through a series of screens to eliminate secondary radiations from the glass walls of the Röntgen tube. The last screen, which gave the final form to the bundle of rays, was a plate of lead a centimetre thick, pierced by a cylindrical hole 0·75 millimetre in diameter, and fitted with a delicate means of adjustment so that the axis of the boring could be brought exactly perpendicular to the crystal plate. The beam of pure Röntgen rays of circular section thus passing through the crystal normally was received, also normally, on a Schleussner-Röntgen photographic plate, which was subsequently developed with rodinal. The time of exposure in different experiments varied from one to twenty hours, the whole apparatus being excluded from all ordinary light by a covering box.

The positive print, reproduced in Fig. 2, from the negative thus obtained shows a central circular black spot, about half a centimetre in diameter, surrounded symmetrically by sixteen smaller black spots of about the same intensity, but of elliptical shape (about two millimetres long), arranged in a diagonally

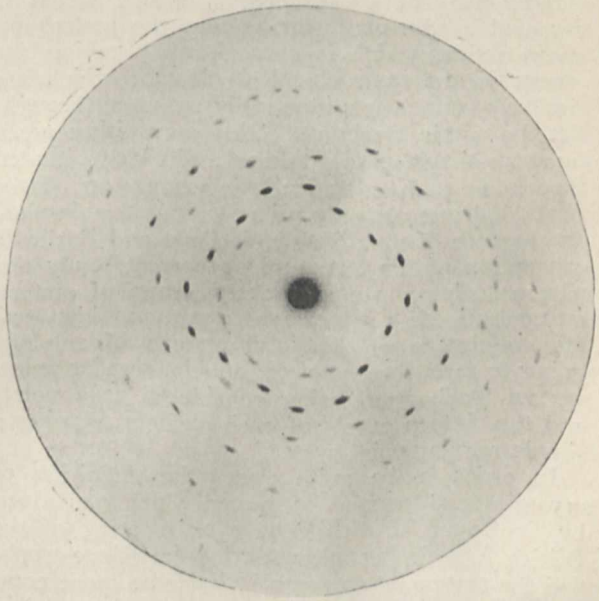


FIG. 2.—Photographic effect of passage of Röntgen rays through zinc blende.

(diamond-wise) placed square, four spots being on each side of the square and separated from each other by about half a centimetre, the centre of the square being exactly occupied by the large spot already alluded to, which was caused by the

direct rays. Outside the square of spots were others of a fainter character, also arranged with similar cubic symmetry, and there was also a faint square of spots inside the intense square, nearer to the latter than to the large central spot.

The tetragonal nature of the axis of symmetry along which the Röntgen rays were travelling through the crystal is most strikingly apparent in the photograph. One recognises at once also the presence of two perpendicular planes of symmetry in the arrangement of the spots. In fact, *the figure corresponds to the holohedral or full symmetry (class 32) of the cubic system*, in spite of the fact that zinc blende belongs to the hexakis-tetrahedral class 31 (one of the so-called hemihedral classes) of cubic symmetry. Now this interesting fact affords the most beautiful and perfect proof that it is the space-lattice (Raumgitter) of the crystal structure which is affording the figure, and that no other property than this space-lattice is concerned. For space-lattices alone always possess holohedral symmetry, and they determine the crystal system and angles and obedience with the law of rational indices. Interpenetrations, translations, and coincidence-movements of space-lattices, which afford those of the sixty-five Sohncke regular point-systems which account for the simpler cases of hemihedrism (types of crystals of lower than holohedral symmetry), are here obviously not concerned; still more emphatically, if possible, is this true of the 165 yet more complicated point-systems involving mirror-image symmetry made known to us by von Fedorow and Barlow.

In other words, it is not the stereographic arrangement of the elementary atoms which is revealed by the photographs, but the underlying space-lattice, which is arrived at by taking the atoms of the same chemical element which are similarly (sameways, identically) situated throughout the whole structure. This may either mean (in very simple cases) taking a similarly situated atom in each chemical molecule, or (more generally) one such atom in a group of molecules. In the case of zinc blende, if Pope and Barlow's conception of the structure be correct,[2] only one zinc or sulphur atom in every group of sixteen molecules is thus sameways orientated, thirty-two atoms (sixteen of zinc and sixteen of sulphur) going to form the complete, double, regular point-system (each atom being considered as a point, and the sixteen atoms of each element forming a simple regular point-system).

In order to be quite clear, the definition of crystal structure may be quoted which was given by Prof. von Groth at the 1904 meeting of the British Association. Mr. Barlow has since amplified the statement so as to include the more complicated cases, but as these are not concerned in the case of zinc blende the definition is fully adequate for our purpose.

A crystal—considered as indefinitely extended—consists of *n* interpenetrating regular point-systems, each of which is formed from similar atoms; each of these point-systems is built up from *n* interpenetrating space-lattices, each of the latter being formed from similar atoms occupying parallel positions. All the space-lattices of the combined system are geometrically identical or are characterised by the same elementary parallelepipedon.

Now the combined system of zinc blende is probably that of the type 63 of Sohncke, and $9a_1$ of Barlow, and in their 1907 memoir, already alluded to, Pope and Barlow describe the probable constitution of the crystals of this substance, on the basis of their assumption that the spheres of influence of the zinc and sulphur atoms are approximately equal, the fundamental acting valency of both elements being here considered as dyadic. If the spheres of influence of the zinc and sulphur atoms, or the parallelohedra into which they are compressed when the interstitial spaces are removed in attaining their closest packed arrangement, were quite equal, the symmetry would be cubic holohedral; but the slight difference in size and the different effect of compression on the atoms of the two elements degrades the symmetry into the hexakis-tetrahedral class 31, next lower in the cubic system. This constitution of the crystals of the simple binary compounds, such as zinc sulphide, does not depend, however, on Pope and Barlow's version of the theory of crystal structure; for the sizes of the spheres of influence of the atoms of the two elements are assumed to be approximately equal, just as is the case when valency is not considered to enter into the problem. It is equally the probable one according to the theory of von Fedorow, based on parallelohedra of cubic and hypohexagonal types, which has led him to the remarkable advance in crystallochemical analysis described by the writer in NATURE of July 18 (p. 503); and as the parallelohedron of von Fedorow represents the combined system (that of Pope and Barlow only representing a single atom), its central representative point is a point of the space-lattice itself. The definition of von Groth is thus equally applicable to both versions.

Thus we are dealing with a crystal supposed to be constructed of two interpenetrating regular point-systems (type No. 63 of Sohncke), corresponding to zinc and sulphur atoms respectively; each of these is composed of sixteen interpenetrating space-lattices, each and all formed from one of the two elements only, and composed of atoms of that element occupying parallel positions. All the thirty-two space-lattices of the double or combined system are geometrically identical, and are characterised by the same elementary parallelepipedon, a cube in this case of zinc blende. Hence one type of space-lattice characterises the whole crystal, and it is this space-lattice, *formed by similar* (consisting of the same element) and *simularly situated atoms*, which has apparently afforded the photograph of spots showing holohedral cubic symmetry. This is equally true whether the structure attributed by Pope and Barlow to zinc blende, or a less complicated one, be the correct structure.

These are the crystallographical facts which must be taken into account in any discussion as

Journ. Chem. Soc. Trans., 1907, xci., 1171 and 1178; see particularly Fig. 17 on p. 1171 and Fig. 1 on p. 1152.

to the nature of these photographs, which does not appear to have been the case in a letter from Prof. W. H. Bragg, which appeared in NATURE of October 24 (p. 219). It would be very interesting if Prof. Bragg would give a revised account of his views after considering these crystallographic data, with which perhaps only a specialist could be expected to be familiar. For it is quite possible that his conclusions may still prove valid when this has been done. But until then judgment must be suspended.

In further confirmatory experiments the crystal was adjusted so that the primary Röntgen rays fell perpendicularly on an octohedral face (111), and subsequently on a rhombic dodecahedral face (110). In the former case the trigonal nature of the symmetry axis along which the rays passed was clearly revealed by three pairs of spots arranged symmetrically to positions 120° apart, while in the latter case the spots indicated the diagonal nature of the axis by being arranged in two pairs only, 180° apart. When the crystal was rotated a few degrees out of exact adjustment, spots of like character still appeared, but no longer symmetrical to the central large spot, affording another confirmation that it is the space-lattice which is responsible for the photographs.

In his Becquerel Memorial Lecture to the Chemical Society on October 17, the text of which is just published,[3] Sir Oliver Lodge referred in the following words to a brief announcement of the important work of Laue and his co-workers which was made by the writer on his return from Munich in September.

> This, if it be a fact, will have to be recognised as a striking and admirable case of scientific prediction, the various crystalline structures and accuracy of characteristic facets having been indicated by theory long before there was any hope of actually seeing them; so that once more—always assuming that the heralded discovery is substantiated—the theoretical abstraction will have become concrete and visible.

It will now be clear, from the detailed memoirs just published, that the writer's announcement is fully substantiated. Crystallography thus affords to its sister science Chemistry the first visible proof of the accuracy of Dalton's atomic theory, and now enters into a new sphere of still greater usefulness. The important work of von Fedorow on crystallochemical analysis, described in the writer's last communication to NATURE (*loc. cit.*), is based essentially on the assumption of the space-lattice structure of crystals which is now rendered visible to our eyes, for the centres or analogous points of his parallelohedra form either one of the fourteen space-lattices or one of nine simple Sohncke point-systems composed of interpenetrating space-lattices; that work is thereby enhanced in value and placed on an absolutely trustworthy basis. Crystallography has thus become an exact science leading us to a practical knowledge of the hitherto mysterious world where Dalton's atoms and molecules reign supreme.

A. E. H. TUTTON.

[3] Journ. Chem. Soc. Trans., October, 1912, CI, 2078.

GEOPHYSICAL MEMOIRS.[1]

BY the authority of the Meteorological Committee, and under the style and title of Geophysical Memoirs, the publication of a series of investigations has been commenced with the issue of the four "blue-books" before us. It is evident that a high standard of value is contemplated; if possible, higher than that of previous "Reports of Investigations in Dynamical and Statistical Meteorology," which appear in the same section of Meteorological Office publications. We shall look forward with interest to the succeeding memoirs, which represent a genuine attempt to dispel the reproach often cast upon meteorologists as mere collectors of undigested statistics with no real claim to the title of men of science.

The subjects of the memoirs already received are quite independent. In No. 1, the Marine Superintendent of the Meteorological Office (Campbell Hepworth, Commander R.N.R.) discusses the effect of the Labrador current upon the surface temperature of the North Atlantic, and of the latter upon air temperature and pressure over the British Isles. It is interesting, in view of the vagaries of the latter within even the last eighteen months, to find it definitely stated that the much-discussed prevalence of ice in the Atlantic is *not* a cause of cold weather here, but only a symptomatic effect of the cold Labrador current, the meeting of which with the Gulf Stream is held responsible for the notorious fogs off the banks of Newfoundland. The discussion of the data for 1903 to 1907 and for most of 1911 is illustrated by an interesting series of plates giving mean sea-surface isotherms of the North Atlantic for January, April, July, and October, thermo-isopleths for surface temperature between Florida Straits and Valencia (Ireland), mean annual surface temperature for every 2° square in the North Atlantic, and separate diagrams for each of the years under discussion, giving monthly prevalence of ice in the Atlantic measured by 1° squares in which it was observed, the sea temperature, and the air temperature and pressure for three British coast stations, Sumburgh Head, Shields, and Valencia. The author's great experience, both at sea and in the office dealing with the mass of observations communicated from ships, renders his views especially worthy of consideration.

In No. 2, Mr. W. H. Dines, the foremost British investigator of the upper air, continues some previous work with discussions of the vertical

[1] (1) "The Effect of the Labrador Current upon the Surface Temperature of the North Atlantic, and of the latter upon the Air Temperature and Pressure over the British Isles." By Commander M. W. C. Hepworth, C.B., Pp. 10+9 plates. Price 9*d*.

(2) "The Free Atmosphere in the Region of the British Isles. Further Contributions to the Investigation of the Upper Air, comprising the Vertical Temperature Distribution in the Atmosphere over England, with some remarks on the General and Local Circulation: Abstract of a paper printed in Volume ccxi of the Philosophical Transactions, Series A, and Total and Partial Correlation Coefficients between Sundry Variables of the Upper Air." By W. H. Dines, F.R.S. Pp. 11–50+plates 10–12. Price 1*s*.

(3) "Graphical Construction for the Epicentre of an Earthquake." By G. W. Walker. Pp. 51–54+plate 13. Price 3*d*.

(4) "On the Radiation Records obtained in 1911 at South Kensington, together with a comparison between them and the Corresponding Absolute Observations of Radiation made at Kew Observatory." By R. Corless. Pp. 55–61+plate 14. Price 3*d*. (London: H.M. Stationery Office and the Meteorological Office, 1912).

temperature distribution in the atmosphere over England, with some remarks on the general and local circulation (this being an abstract of a paper appearing in the Philosophical Transactions of the Royal Society), and with total and partial correlation coefficients between sundry variables of the upper air. The main conclusions, as we gather from Dr. Shaw's preface to this memoir, are that the upper regions of cyclonic areas are colder than those of anti-cyclonic areas, and that the temperature up to the stratosphere varies in the same direction as the pressure at the surface, and that a close relation exists between the five quantities—pressure at ground level, mean temperature up to nine kilometres, pressure at nine-kilometre level, height of troposphere, and temperature of stratosphere. Illustrations are given of progessive changes in cloud formation.

In No. 3, Mr. G. W. Walker, superintendent of Eskdalemuir Observatory, which has become answerable to the Meteorological Office, gives a graphical construction for the epicentre of an earthquake; and in No. 4 Mr. R. Corless, who, as Dr. Shaw's scientific secretary, is following in the footsteps of such men as Dr. G. C. Simpson and Mr. Ernest Gold, deals with the radiation records obtained in 1911 at South Kensington, together with a comparison between them and the corresponding absolute observations of radiation made at Kew Observatory. We need only remark that it would be more satisfactory for some purposes if a more direct comparison could be made than one between a vertical instrument at one station and a total radiation instrument at another station, operated for only part of the time. Mr. Corless himself emphasises this difficulty, but apart from the comparison with Kew, the actual observations are of great interest, and show among other results the inadequacy of the sunshine instrument as a radiation recorder.

W. W. B.

THE BIOLOGY OF THE FIG-TREE AND ITS INSECT GUEST.[1]

WE take advantage of a recent treatise on fig-culture to enlarge and correct what has hitherto been taught about the biology of the fig-tree and its insect guest, Blastophaga. Our new information is drawn from Dr. Ruggero Ravasini's "Die Feigenbäume Italiens" (Bern, 1911), which gives the results of a prolonged study made in Italy. The research has been directed by Prof. A. Tschirch, of Bern; for the detailed observations and experiments we have to thank Dr. Ravasini, who, in addition to his scientific attainments, enjoys the advantage of being an Italian, and thereby better able to win the confidence of Italian fig-growers. Fig-cultivators and all biologists who make a special study of the fig-tree will, of course, betake themselves to the original treatise, which is clear, interesting, well-illustrated, and not too lengthy. We shall here address ourselves to those biologists for whom a less complete exposition will suffice, at least for the moment.

The structure and life-history of the fig-tree have been modified by long-continued cultivation; and in order to simplify the presentation of the facts, we shall first describe the reproductive process in the wild fig-tree, which still maintains itself in Italy, probably also in all fig-growing countries where the ground is not too closely occupied by cultivation.

The wild fig-tree is monœcious, its unisexual flowers being collected into mixed inflorescences. In remote ancestors of the figs the head may have taken the usual flattish or convex form. Dorstenia, an allied plant, which is now and then seen in hothouses, bears a crowd of small greenish flowers on a flattened disc about an inch wide. In a fig the edges of the disc close in upon the flowers, and we get a hollow, pear-shaped receptacle lined with minute, crowded, unisexual flowers. The opening is not only narrowed, but further obstructed by outward-pointing scales. During ripening the wall of the receptacle becomes thickened, and the central cavity almost disappears. In Dorstenia the small fruits are shot out by the turgidity of the wall; in the figs the wall may become eatable, and promote the dispersal of the seeds in another fashion.

The wild fig-tree bears three different kinds of inflorescence, according to the season of the year. There is a *spring inflorescence*, bearing male and sterile female flowers; a *summer inflorescence*, which bears only fertile females; and a *wintering inflorescence*, which bears only sterile females. Sterility here results from the adaptation of female flowers to the nutrition of fig-wasps (Blastophaga); the sterile flowers are hence called *gall-flowers*. In the cultivated fruiting fig-tree sterile pistillate flowers of another kind occur.

The process of pollination of the fig by Blastophaga is comparatively familiar, but it may be briefly described here to save the necessity of reference to books. Blastophaga is a small Chalcidid hymenopterous insect. The male is wingless, and the female (which alone passes from one inflorescence to another) winged. In spring, impregnated females issue from the wintering inflorescence and fly to the spring inflorescence. Here they lay eggs in the gall-flowers, one egg to each flower, and from these eggs both male and female flies proceed. When full grown, the male crawls sluggishly about until he becomes aware of the presence of a female still enclosed within the ovary of a gall-flower. Then he bites a hole in the ovary, passes in the tapering, pointed end of his abdomen, and effects his purpose. Since the male rarely quits the inflorescence, he has no need of wings or eyes; accordingly there are no wings, and the eyes are poorly developed; even the antennæ are small and few-jointed; the mandibles, however, and two of the three pairs of legs, are powerful.

The winged female after impregnation bites off the top of the ovary, and makes her way into

[1] "Die Feigenbäume Italiens und ihre Beziehungen zu einander." By Dr. Ruggero Ravasini. Pp. 174+6. (Bern: Max Drechsel, 1911.) Price 11 marks.

the central cavity of the spring inflorescence. The staminate flowers, set in a ring round the outlet, are now ripe, and the issuing female gets dusted by their pollen. Then she flies to the immature figs of the summer generation (we are still speaking of the wild fig-tree), which contain only female flowers. In her fruitless search for gall-flowers in which to lay her eggs, she pollinates the female flowers. So many Blastophagas are deceived by appearances that whenever a wild fig-tree is shaken in July or August, swarms of the flies come out of the summer figs. Is it possible that they procure food for themselves there?

Ravasini shows that in the wild fig-tree there are only two sets of gall-flowers, one in the wintering, another in the spring inflorescences. He believes that there are also only two sets of Blastophagas, answering to the two sets of gall-flowers. One female Blastophaga may suffice for an entire inflorescence, so that there is a great superfluity of insects.

In October the wintering inflorescences are ready, and the later-hatched Blastophagas of the spring generation enter them to lay their eggs in the gall-flowers. The life-cycle of the insect is thus completed.

We must now add a few words about cultivated fig-trees.

When men began to plant wild fig-trees in their gardens, they would, of course, propagate them by cuttings. Now cuttings of the wild fig-tree are found to reproduce the characters of the *branches* from which they were taken. By taking cuttings from branches destined to bear spring inflorescences, trees have been produced in which only the spring inflorescences regularly attain complete maturity; these trees are Caprifigs (goat-figs), which are practically male. In the same way, by using as the parent stock branches which bear summer inflorescences, trees have been produced which are entirely female. Of these two the caprifig alone is capable of harbouring the insect guest during its growth period.

Two fig-trees, very different in appearance and function, have thus been developed by the action of man out of the single primitive stock; they are often called *varieties,* but Tschirch and Ravasini show that they are really *artificially produced sexual forms* of one and the same natural species, viz. of the wild fig-tree. One proof is that seeds of the cultivated fig-tree produce either caprifigs or inferior fruiting figs. A further proof is yielded by the fact that the female Blastophaga, when laden with eggs, can only fly a very short distance. Hence we infer that she is adapted to a monœcious fig-tree, in which all the forms of inflorescence are to be found on one tree. The cultivated fig-tree is practically diœcious, and without artificial pollination ripens no seed. Only one monœcious tree is known, which can be regarded as a possible common ancestor of the two interfertile forms, caprifig and fruiting cultivated fig; this common ancestor is the wild fig-tree.

Fig-cultivators must have become early acquainted with the Blastophaga and the effects of its visits, for the female flowers of the fig remain unfertilised if no Blastophaga enters them, and unfertilised female inflorescences (in unimproved fig-trees) fall off prematurely. To prevent such failures, the expedient was successfully tried (ages ago) of fastening to the female trees ripe staminate inflorescences of the wild fig-trees. Blastophagas and pollen were thus supplied together, and the female inflorescences duly ripened. In course of time the inflorescences of the wild fig-tree were replaced by those of the caprifig, which answer the same purpose, and are easily raised on the spot. Thus arose the practice of "caprification," which is essential to the production of the best keeping or drying figs.

The dried figs of commerce, which are all seed-bearing, absolutely require fertilisation by the Blastophaga, and this is most easily secured by caprification. But if only *fresh* edible fruits are desired, caprification may be dispensed with. By long-continued selection it has been found possible to create varieties in which the unfertilised figs do not fall off prematurely, but develop into a valuable fruit. The large, non-seeding, sweet and juicy table-figs of north and mid-Italy require no pollination at all. Ravasini calls this the greatest triumph of fig-culture.

We have not explained all that we should like to explain, but enough, we hope, to send some of our readers to "Die Feigenbäume Italiens," and to make them look out for the further experiments which Dr. Ravasini promises.

L. C. M.

NOTES.

THE next meeting of the International Union for Solar Research will be held at Bonn on Friday, August 1, 1913, and succeeding days.

A REUTER message from Stockholm announces that the Swedish Royal Academy of Sciences has awarded the Nobel prize for physics for 1912 to M. Gustaf Dalen, a Swiss engineer, the head of the Stockholm Gas Company, and the prize for chemistry has been divided between Prof. Grignard, of Nancy University, and Prof. Sabatier, of Toulouse University.

THE council of the Royal Scottish Geographical Society has resolved to award the Livingstone gold medal to Captain Roald Amundsen and the society's silver medal to Captain Egnar Mikkelsen, the leader of the Danish expedition to north-eastern Greenland, in recognition of their services to geographical science.

WE are glad to learn that the Chilean Government has sent instructions to the Chilean authorities at Easter Island to afford every assistance in their power to the expedition organised and led by Mr. and Mrs. W. Scoresby Routledge. The main object of this carefully planned and well-equipped expedition is to make a topographical and archæological survey of Easter Island, the most remote of Polynesian islands, which is famous for its megalithic monuments, of which visitors to the British Museum have seen examples in the portico. There are many problems of extreme interest concerning the culture of the natives,

of whom it is said no pure-bred descendants now exist. Mr. Routledge and his colleagues have a most fascinating field for research, and we wish them every success.

WE regret to notice the death, in his eighty-first year, on November 6, at the University of Virginia, U.S.A., of Prof. J. W. Mallet, F.R.S., professor of chemistry in the University, and joint author, with his father, of the British Association catalogue of earthquakes.

THE death is announced, at the age of ninety years, of M. Aimé Pagnoul, a French authority on agricultural chemistry. In 1869 M. Pagnoul organised the agricultural station of the Pas-de-Calais, of which he was director until 1899; and in 1894 he was elected a correspondant of the Paris Academy of Sciences in the section of rural economy.

THE Decimal Association announces that a large majority of American jewellers has agreed to adopt the metric carat of 200 milligrams as from July 1, 1913. A committee has been formed to promulgate the passage of a law making the metric carat effective throughout the country. It is probable that the adoption of this new carat by the jewellers of the United States will hasten its introduction here.

THE 159th session of the Royal Society of Arts will be opened on Wednesday evening, November 20, by Lord Sanderson, G.C.B., K.C.M.G., chairman of the council, who will deliver an address and distribute the medals awarded last session. Mr. A. Zimmermann will describe "The Manufacture of Sugar from Wood, and its Economic Importance," on December 4, and Dr. F. Mollwo Perkin will read a paper on synthetic rubber on December 11. In the Colonial Section, Prof. W. H. Warren will describe "The Hardwood Timbers of New South Wales" on November 26. A course of Cantor lectures will also be delivered by Mr. C. R. Darling on "Methods of Economising Heat" on Mondays, December 2, 9, and 16.

THE following is a list of those who have been recommended by the president and council of the Royal Society for election into the council for the year 1913 at the anniversary meeting on November 30:—*President*, Sir Archibald Geikie, K.C.B.; *Treasurer*, Sir Alfred B. Kempe; *Secretaries*, Sir John Bradford, K.C.M.G., Prof. A. Schuster; *Foreign Secretary*, Dr. D. H. Scott; *Other Members of the Council*, Lieut.-Col. A. W. Alcock, the Right Hon. A. J. Balfour, Sir William Crookes, O.M., Dr. F. W. Dyson, Prof. W. Gowland, Sir Joseph Larmor, Prof. E. W. MacBride, Mr. W. B. Hardy, Prof. Micaiah J. M. Hill, Sir Ronald Ross, K.C.B., Prof. G. Elliot Smith, Prof. A. Smithells, Dr. J. J. Harris Teall, Prof. Silvanus P. Thompson, Prof. Sir J. J. Thomson, Sir Philip Watts, K.C.B.

THE Zoological Society of Los Angeles, California, was established in August, 1911, to further the project of starting a collection of wild animals in Griffith Park in that city, and we are glad to learn from the first number of its Proceedings that the idea has already taken practical shape. The necessary funds are being raised by private subscription, aided by a substantial grant from the City Council. Judging from the description, the site and climate seem to offer ideal conditions for the exhibition and preservation of animals in extensive ranges, varying in area from fifteen to one hundred and twenty-five acres. To this is to be added a marine aquarium to be placed on the sea-front on the cliffs skirting the base of San Pedro Hill. To zoologists will be especially welcome the announcement that although the animals are to be kept primarily as part of the park system for the pleasure and instruction of the people, a special feature of the institution will be a prosectorial department, where the anatomy and pathology of the dead animals may be investigated. We heartily wish the project all success.

A COPY of the programme for 1912 of the Société Batave de Philosophie expérimentale de Rotterdam has been received. The gold medal of the society, or its value in money, as the successful candidate may determine, will be awarded to each candidate whose paper on a scientific question proposed by the society is considered most satisfactory by a general meeting of members. The programme includes some forty-five questions to which competitors may address themselves. The general character of the inquiries proposed by the society may be gathered to some extent from the following examples: an anatomical and physiological description of one or more species of a family of plants which up to the present has not been examined satisfactorily in this way; magnetic variations and disturbances; an exact and critical review of our present knowledge of the volcanoes and volcanic phenomena in the East Indies; an experimental research into the thermoelectric properties of some metallic alloys, with special reference to the influence of the composition of the alloy; a study of the origin, physiological significance of the green colouring matter in the bodies of certain animals, structure and development of a species of trypanosome, &c. The theses may be written in Dutch, French, German, or English, and should be in the hands of the secretary of the society by February 1, 1914.

ON November 7, a conference of museum curators and others interested in museum work was held at the Manchester Museum. Mr. H. W. Freston, chairman of the Manchester Museum Standing Committee, presided, and representatives from twenty-eight museums were present. In a paper on pigmy flint implements, Mr. W. H. Sutcliffe, of Rochdale, maintained the opinion that the shouldered type of these implements was used by Neolithic man to form a kind of carding tool, by fixing numbers of them up to the shoulder in a wooden stock, with which the muscle fibres and sinews adhering to skins used for clothing could be teased and loosened after curing, the skin being rendered by this means soft, pliable, and capable of being made into close-fitting garments. The chief opposition to this theory was based on the grounds (1) that no trace of wooden stock had ever been found with pigmy flints; (2) that only a small percentage of the flints showed any signs of wear or usage; (3) that

the fine sharp points of the majority suggested their use for some such purpose as tattooing. Mr. Sutcliffe replied to these objections as follows:—(1) That, from the analogy of other Neolithic implements, such as hammers and axes, in which the use of a wooden haft was postulated, though traces of such a haft were seldom found, the objection on this ground failed; (2) that in his experience 46 per cent. of the flints were blunted and worn; and (3) they were much more numerous than one would expect tattooing implements to be.

THE Smithsonian Institution has just issued three papers describing further new material collected during the biological survey of the Panama Canal zone, including new insects, mammals, and birds. This survey was inaugurated in 1910 and carried on for two seasons. Early this year Mr. E. A. Goldman, of the Biological Survey, U.S. Department of Agriculture, went to Panama for the second time and made additional collections of mammals. The collection of natural history specimens, which includes some 800 birds and 595 mammals, indicates that the fauna of eastern Panama is South American in its general characteristics. The new birds of the region have been described by Mr. E. W. Nelson in a pamphlet entitled "Descriptions of New Genera, Species, and Subspecies of Birds from Panama, Colombia, and Ecuador." Many of the specimens were collected by Mr. Goldman, who seems to have been the first zoological collector to have penetrated the forests about Mount Pirri and its bordering lowlands. Here many birds and mammals not before known from Panama were taken, a number of which were also new to science. Several species of South American animals appear to reach their northern limit at this point, being unknown in the Canal zone and the adjacent territory, although only about 150 miles distant. Mr. J. R. Malloch, of the Bureau of Entomology, Department of Agriculture, has written a technical description of three new species of Diptera from Panama. The three papers just issued are Publications Nos. 2141 to 2143 in the Smithsonian Miscellaneous Collections.

A RECENT number of the "Annals of Tropical Medicine and Parasitology" (vol. vi., No. 3) contains a memoir by Drs. J. G. Thomson and J. A. Sinton on the morphology of *Trypanosoma gambiense* and *T. rhodesiense* in cultures, with a comparison between the cultural forms and those known to occur in the natural development that takes places in the tsetse-fly (*Glossina palpalis*). The life-history of these trypanosomes in culture-tubes was found to be similar to that which occurs in the gut of the insect-host. An interesting parallel with the natural development was further shown in the fact that the cultures of the trypanosomes quickly lose their infectivity, and after the third day are not infective to rats by intraperitoneal injection. In the cultures the trypanosomes do not regain the infectivity which in tsetse-flies they acquire again by passing into the salivary glands of the fly. The authors found no evidence of a sexual cycle, although the so-called "male" and "female" forms are present in the cultures.

FROM a small guide-book compiled by Mr. T. Sheppard, we learn that the town of Scunthorpe, Lincolnshire, situated in the heart of the ironstone district, possesses a small museum, which is specially devoted to local palæontology, antiquities, and natural history. The guide contains illustrations of ironstone fossils, prehistoric implements, and ancient Roman vases.

FROM the report of the Inspector of the Eastern Sea Fisheries for the year ending September 12, it appears that during the period under review not only has the catch been for the most part unsatisfactory—largely owing to bad weather—but that on the Norfolk and Suffolk coast foreign trawlers are alleged to have approached too near the land, while on the Lincolnshire coast several steam-trawlers are stated to have run the risk of being caught at work within the territorial limit. As complaints are rife—as, for instance, at Torbay—with regard to the depletion of fisheries by our own trawlers, it is only justice to our fishermen that they should be adequately protected from foreign poaching.

THE first volume of the second series of the Memoirs of the American Museum of Natural History commences with a description by Prof. H. F. Osborn of the skull of the gigantic theropod dinosaur *Tyrannosaurus rex*, from the Upper Cretaceous of Montana, together with notes on the skulls of Allosaurus and the Theropoda in general. The skull of Tyrannosaurus, which is furnished with a formidable armature of teeth of the megalosaurian type, is not only the largest in the theropod order, but, speaking generally, is also the most powerful and massive among reptiles as a whole; this may be verified by the inspection of a cast exhibited in the fossil reptile gallery at the Natural History Museum. A noteworthy feature is the fusion of the vomers into a single diamond-shaped plate, articulating posteriorly by a long style with the pterygoids, since a practically identical structure exists in the ostrich group. As an adaptive modification correlated with the powerful dentition, attention is specially directed to the antero-posterior shortening of the skull and the reduction of the number of pairs of teeth from twenty (in Allosaurus) to sixteen. This abbreviation of the skull is paralleled among modern cats and certain extinct dog-like carnivores. The homology of certain bones of the theropod skull is also discussed. In a second article in the same issue Prof. Osborn describes in detail, with photographic illustrations, the skin of the iguanodont dinosaur *Trachodon annectans*, from the Upper Cretaceous of Wyoming, as preserved in a "mummified" skeleton. Since reference was made last year in NATURE to a preliminary account of this wonderful specimen, further notice is unnecessary.

WE have received four parts of the zoological reports on the collections made by the Duke of Orleans in his Arctic expedition on the *Belgica* in 1907. ("Campagne Arctique de 1907." Duc d'Orléans. Bruxelles: C. Bulens, 1911–12.) The Siberian Sea, along the coast of Nova Zembla, has not been much explored, and these handsomely got-up volumes contain many in-

teresting records and descriptions. Dr. Louis Stappers deals with the higher Crustaceans, and attention may be directed to the very fine figures illustrating species of Leptostylis. Prof. Pierre Fauvel reports on the Annelids, of which fifty-two species were collected. It is interesting to notice that only one of these was new, namely *Sphaerodorum philippi*. It appears that almost all the boreal Annelids are represented throughout the circumpolar area, and it is remarkable that some occur so far south as the Azores, the Mediterranean, and the Indian Ocean. The Bryozoa are discussed by O. Nordgaard, who reports the occurrence of sixty species in the Kara Sea alone. From a single station twenty-seven species were obtained, and the abundance of superb specimens of *Reticulipora* (*Diastopora*) *intricaria* is a conspicuous feature in many places. It seems that Bryozoa flourish particularly well in localities with a rapid current and abundant plankton organisms. The great majority of the species collected by the *Belgica* are distinctively Arctic, a number are boreal, three are almost cosmopolitan. Dr. Hjalmar Broch reports on the Cœlentera —twenty-six Hydroids, five Alcyonarians, and two sea-anemones. In some cases the occurrence is of great interest as regards the geographical distribution of the species. Thus *Eunephthya clavata*, reported from the Kara Sea, has also been recorded from the Azores.

A REPORT on the structure and development of crown gall, a plant cancer, by Mr. E. F. Smith and Misses N. A. Brown and L. McCulloch, has been issued by the U.S. Department of Agriculture (Bureau of Plant Industry, Bull. 255). The disease attacks a variety of plants, is infectious, and is caused by bacteria, either one polymorphic species, or several closely related species. A full description of the organism, named the *B. tumefaciens*, and of its cultural and biological characters is given. The development of the disease is regarded as closely simulating what takes place in cancer of man and animals, though metastases do not occur, and, of course, this disease of plants has nothing to do with mammalian cancer. The report is illustrated with no fewer than 109 full-page half-tone plates.

FROM Dr. C. R. Wieland we have received reprints of four papers contributed to *The American Journal of Science*, containing the results of his further observations on the fossil Cycads, and thus forming a supplement to his great work on "American Fossil Cycads," published in 1906. In a note on seed structure in the Cycadeoideæ (Bennettitales), the author remarks that the seed and embryo of these Mesozoic forms are of the most generalised gymnospermous type, while their retention of pronounced cycadofilicinean features further favours inclusion in the Cycadales; apparently the primitive seed characters of the Cycadeoideæ were only slightly obscured by appression in the cone type of fructification, and were by this very appression so much the more surely conserved as to permit free comparison with the ancestral singly-borne leafy seeds of the Palæozoic forms. Another note is devoted to the mature but pigmy flowers of *Cycadeoidea Marshiana*, and to a discussion of the probable relationships between Cycadeoideæ, Cycads, Cycadofilices, and Gnetales. A third paper deals with the author's own examination of certain historic fossil Cycads described by earlier writers; while the fourth contains a general review of the Williamsonia and Cycadeoidea tribe, with special reference to types recently discovered in Europe, and a provisional classification of the forms now known.

THE Patent Office has isued part i. of a "Subject List of Works on Mineral Industries" (Darling and Son, price 6*d*.), which shows how much good material is available for public consultation in the library in Chancery Lane, London. In this part the geological sciences and coal mining are included, and mineral industries and practical mining come under these heads. The detailed classification adopted prevents the ready discovery of books on a given subject, since several headings may be consulted in vain before the right one is discovered. Rutley's "Felsitic Lavas" thus appears under "Lavas" and not also under "Petrology"; his Brent Tor memoir is found under "Petrology, Igneous Rocks," and not also under "Geology, Descriptive, Devonshire." The division of geology into economic, descriptive, and stratigraphic renders the publications of geological surveys extremely hard to classify. A few repetitions and cross-references are conveniently introduced; but the memoirs on the South Wales coalfield appear under none of the above headings, not even under "Economic—local—Wales," but only under "Coal, Distribution." Hardman's memoir on the Leinster coalfield seems to have no separate mention, and there is no heading "Carboniferous" under "Geology, Stratigraphic." The miner comes off somewhat better, with good lists of works on nitrates, phosphates, &c.; but a far broader classification, with subheadings alphabetically arranged, will be of much service to the reader when the list is next revised.

THE aggravating contrast between the heavy rainfall on the rugged eastern highlands of Australia and the arid climate of the rich-soiled plains to the west has led to many projects for the more useful distribution of the water. The most important scheme in New South Wales is that for collecting the winter floods of the Murrumbidgee River for use during the summer by the construction of a vast reservoir with a dam 240 ft. in height. The reservoir will be one of the greatest in the world, as it will hold 33,000,000,000 cubic feet of water, or a greater amount than that contained in Sydney Harbour. The water will be conducted by channels, which may amount to 1000 miles in length, and be used for the irrigation of a large area more than 100 miles to the west. The reservoir is in a locality hitherto known as Barren Jack; this is a corruption of an aboriginal name, Burrinjuck, which has been officially adopted. The New South Wales Government is advertising for applicants for the land which can thus be brought into cultivation, and has issued a pamphlet, by Mr. L. A. B. Wade, the chief engineer for irrigation and drainage, on the progress of the work.

THE *Mitteilungen* from German Protectorates (vol. xxv., part 3, 1912) contain the monthly and yearly summaries of the meteorological observations at stations of the second order, and at the rainfall stations in Togoland (equatorial West Africa) for the year 1911. The summaries have been very carefully prepared by Dr. P. Heidke, of the Deutsche Seewarte, and include in the accompanying text much valuable information relating to the climate of that district. It is satisfactory to note that the observers take much interest in their work; at many stations they have considerably exceeded what was required of them.

No better evidence of the paucity of scientific knowledge amongst Englishmen supposed to be well educated has ever been afforded than was given in the House of Commons during the discussion of the Bill for the adoption of the metric system five years ago. A responsible Minister of the Crown then stated that "the metric system had broken down in France," and the House appears to have believed him. To those whose information on the subject is not up to date, an article by Dr. C. E. Guillaume in the *Revue générale des Sciences* for October 15 will be of great value. It shows that the other systems have almost entirely disappeared, the only ones at present in use being the Anglo-Saxon, the Russian, and the Japanese, while Japan has recently adopted the decimal system with a view to further reform in the near future. Australia, New Zealand, and South Africa are anxious that the British Empire should adopt the system, and it begins to look as if the Mother Country would be left in sole possession of a system which the average man finds so difficult to remember that he cannot say how many multiples a pound or an ounce is of a grain, or a mile of a yard, or what is the definition of a gallon.

THE Proceedings of the University of Durham Philosophical Society for 1911–12 (vol. iv., Pt. 4) contains the following papers:—The stability of a floating triangular prism, Mr. F. H. Alexander; the effect of soil aëration on plant growth, Mr. C. Hunter; chemical reactions taking place at the kathode and anode during the electrolysis of simple salt solutions, Dr. J. H. Patterson; the preparation of benzyl mercaptan, Dr. J. A. Smythe; the preparation of acrylic ester, Dr. F. G. Trobridge; some para derivatives of phenylacetic acid, Mr. S. Robson; analysis of a Florida Clay, Dr. A. A. Hall; and the rate of fermentation as measured by difference of potential, Dr. M. C. Potter. The society includes 171 members, and held 21 meetings, at which 26 papers were read, during the session 1911–12. The sixth report of the Boulders Committee is printed in the present issue of the Proceedings.

MR. ROBERT ELLIOTT-COOPER'S presidential address to the Institution of Civil Engineers is largely composed of an interesting discussion of the labours of the civil engineer in the oversea dominions of the British Empire. Dealing with the Grand Trunk Pacific Railway in Canada, while there is much to admire in this huge undertaking and its accessories, there is one matter which will not find general acceptance in these days of picturesque town-planning, except perhaps from those who think, with Ruskin, that railways and æstheticism are absolutely irreconcilable. The new townships which have been and are about to be established along the undeveloped lengths of the new line are, as nearly as possible, eight miles apart, centre to centre, and are all on the northern side of the railway. In each town is one main street, named so in every case, 80 ft. wide, and leading up to the precise centre of the station, while there are 60-ft. streets at exactly equal distances apart on a chess-board pattern, completing a perfect square. A few of these perhaps would not affect the traveller much, but, when 1000 miles covering 125 towns of this description are passed, it will take all the sublime diversity of the scenery of the Rocky Mountains to soothe his irritated nerves.

MR. JOHN MURRAY has published a translation by Mr. W. C. Clinton of Dr. L. Bloch's "Science of Illumination," which was reviewed in these columns on March 7 last (vol. lxxxix., p. 3). With the consent of the author, Mr. Clinton has made certain alterations and additions rendered necessary by the difference between the English and German units and standards, and by the lapse of time. The price of the English edition is 6*s*. net.

MR. FRANCIS EDWARDS, bookseller, of 83 High Street, Marylebone, London, W., has issued a catalogue of the geographical library of Mr. Ernest G. Ravenstein. The catalogue includes some 1197 entries of works which he has for sale. Messrs. Bowes and Bowes, 1 Trinity Street, Cambridge, have published a catalogue of books on pure and applied mathematics which they have on sale. The list deals with mathematical histories and dictionaries, mathematical works published before 1700, and works of reference.

OUR ASTRONOMICAL COLUMN.

THE BRAZILIAN ECLIPSE, OCTOBER 10.—We learn from Mr. J. H. Worthington that his private eclipse camp in Brazil was in the same locality as that of the Greenwich observers, and that rain entirely prevented observations. He further states that it would probably have been necessary to travel at least a thousand miles to escape the rain zone on the day of the eclipse.

BORRELLY'S COMET 1912*c*.—Circular No. 137 from the Kiel Centralstelle gives a set of elements and an ephemeris for the comet discovered by M. Borrelly on November 2. From these we see that the comet passed perihelion on October 22, when it was some 103 million miles from the sun, and is now travelling southwards through Hercules towards Aquila; on November 18 it will be about 25 m. east of ϵ Aquilæ. The distances from both the sun and the earth are increasing, and consequently the calculated magnitude, now 8·7, is decreasing.

In a letter in *The Times* of November 13, Mr. W. S. Franks states that the comet was observed on November 9 at Mr. F. J. Hanbury's observatory, Brockhurst, East Grinstead, with the 6-in. equatorial. "At 8.10 p.m., November 9, its approximate right ascension was 18h. 37m., and declination 27° 33′ N. It was fairly bright, and estimated as of about seventh magnitude, being easily visible in the finder. It was judged to be about 1′ of arc in diameter, gradually brightening to the centre, but without a nucleus."

THE LIGHT-CURVE OF NOVA GEMINORUM, NO. 2.—The results of about 270 magnitude-observations of

Nova Geminorum, No. 2 (1912), made between March 12 and the end of May, are published and discussed by Herr J. Fischer-Petersen in No. 4608 of the *Astronomische Nachrichten*. The light-curve shows oscillations somewhat similar to those of Nova Persei in 1901, but of less amplitude and longer period. The maximum magnitude, 3·8, was reached on March 14, and then there was an abrupt fall, to 5·4, on March 16; subsidiary maxima occurred on March 24, 30, April 3 and 9, that on the first-named date being very marked (mag. = 4·8). After April 9 the undulations of the curve are very small.

THE DARK STRUCTURES IN THE MILKY WAY.—An interesting paper full of suggestion as to the structure of the universe is contributed by the Rev. T. E. Espin to No. 4, vol vi., of the Journal of the Royal Astronomical Society of Canada. Mr. Espin recalls Caroline Herschel's idea that a blank region in Scorpio was believed by Sir William Herschel to indicate "something more than a total absence of stars," and then, by the examination of other blank regions, he proceeds to show that in all probability there exist in the heavens masses of dark, light-absorbing vapours, which hide from us the light emitted by stars or parts of nebulæ in the background. The photographic evidence seems almost irrefutable, it being difficult to explain otherwise such observations of Dr. Kopff's that "nearly all faint stars have disappeared from the immediate surroundings of these nebulæ, though they are ten times more numerous, both in the nebulæ and far outside." But if we suppose the bright nebulæ which are shown on our photographs to have margins which are too diffuse to become illuminated, yet dense enough to absorb, the difficulty is removed, and if this absorbing margin, or extension, is projected, by the position of our view-point, on to the main body of the bright nebula, the "holes" and "lanes" observed in such nebulæ are similarly explained. A number of beautiful photographs to illustrate Mr. Espin's article are reproduced.

Dr. Chant also has a paper in the same journal, dealing with nebulæ and their forms, and this, too, is illustrated by many interesting reproductions.

STELLAR ACTINOMETRY AT THE YERKES OBSERVATORY.—A paper of great importance to astrophysicists and workers in stellar photometry is published by Mr. J. A. Parkhurst in No. 3, vol. xxxvi., of *The Astrophysical Journal*. For many years Mr. Parkhurst has been working on the relations existing between photographic and visual magnitudes, and has published details of a method whereby both could be measured photographically. He now publishes the results of a much more extended research, and gives both the photographic and visual magnitudes for some 650 stars, down to magnitude 7·5, in the Potsdam Photometric *Durchmusterung*, from 73° to the pole. The photographic magnitudes were measured from extra-focal images on Seed 27 plates, and the "visual" from reflector plates taken in the focus on colour-sensitive plates, and with a specially prepared colour-filter; Mr. Parkhurst fully describes the ingenious methods of eliminating or determining the numerous errors inherent to the observations. Then in his catalogue he gives the colour index of each star and, where possible, the type of spectrum; comparisons with the results obtained by other observers show fair agreement. The relation between spectrum and colour index, using the Harvard classification for the former, is best represented by a straight line, the differences being so slight as not to warrant the introduction of any complex curve to show the relation. There were 402 stars in this catalogue bright enough to give spectra which could be classified, and, of these, exactly half belong to the types B_2 to F_0, and half to types F_1 to M; 196, or 40 per cent., are of the A type. At the nearest approach to the galaxy, viz. 10° in R.A. 1h., each field showed some ten or twelve white stars, while at the greatest distance from it, viz. 44° in R.A. 13h., there were only two or three white stars per field.

THE IRON AND STEEL INSTITUTE.

THE autumn meeting of the Iron and Steel Institute, which was held at Leeds on September 30 and October 1–4, may fairly be described as a "practical man's" meeting, for although the programme contained approximately an equal number of "practical" and "scientific" papers, those read and discussed at the meeting belonged entirely to the former class. While this is no doubt satisfactory to a large number of members of the institute who take rather less interest in scientific metallurgy than might fairly be expected of them, it is rather hard on the authors of scientific papers and on those members who were attracted to the meeting by the array of such papers on the programme. It is true that on other occasions the programmes have erred in the opposite direction, and it may be hoped that at future meetings a judicious blending of both types of papers may be brought up for discussion.

Among the papers relating to steel-works practice, the greatest interest and importance attaches to those dealing with the question of the production of sound ingots. Sir Robert Hadfield, F.R.S., who presented papers on a method of producing sound ingots and on a new method of revealing segregation in steel ingots, introduced the subject by referring to the series of alarming rail-fractures which had occurred in America during the exceptionally severe weather of last winter. These failures, and others which occur under less severe conditions, he is inclined to ascribe to unsoundness in the steel ingots from which the rails are rolled. According to the treatment and additions which a steel has received, the resulting ingot may suffer from unsoundness of one of two distinct types; the ingot may be more or less full of cavities or blow-holes of varying size and distribution, and in that case it is a non-settling, non-piping steel in which gases have been liberated during solidification in the mould. On the other hand, by suitable additions of small quantities of silicon or of aluminium, the steel may be rendered "solid" or "settling" in the sense that the ingot will be free from blow-holes or small distributed cavities, but it will—in the absence of special treatment—have a deep central cavity or "pipe," the existence of which results either in the discarding of a large proportion of the finished steel by the rejection of the upper portion of the ingot, or, if the piped portion is not sufficiently discarded, an unsound rail may be rolled from it, possibly with disastrous consequences.

In one of his papers Sir Robert Hadfield suggests a method of studying the formation of such pipes by pouring molten copper into the ingot at a certain stage of its solidification. He illustrates this method by coloured sections of ingots thus treated, but in the discussion Dr. J. E. Stead, F.R.S., pointed out that the copper when poured in will partly alloy with the still molten steel, and will then, by its greater density, produce an upward displacement of the remaining liquid steel, so that Hadfield's pretty method is really only applicable if the copper is introduced immediately after the complete solidification of the steel. Even if introduced earlier, however, the copper makes it possible to trace the order in which the various parts of

an ingot have solidified, and even that information is of some importance.

Sir Robert Hadfield's method for producing sound ingots consists in producing solid "piping" steel, and then arranging matters in such a way that the tendency to form a pipe is neutralised by a full supply of hot liquid steel from above. This is attained by attaching to the top of the ingot-mould a "feeding head" lined with sand; this practically constitutes an upward continuation of the ingot-mould, and when the mould is filled the steel is allowed to rise to some distance into this attachment. The steel in this feeding-head is, however, to be kept molten until the solidification of the ingot proper is completed, and this is attained in Hadfield's process by covering the surface of the steel first with a thin layer of cupola slag, which serves to protect the metal against both thermal loss and chemical contamination, and then with a layer of charcoal, which is brought into a lively incandescence by the action of a blast of compressed air. The author gives numerous examples and full particulars of results attained in this way, and although in the discussion on this subject doubts were expressed as to the practicability of the process, and to some extent as to its novelty, its efficacy was admitted.

Another method intended to serve the same purpose of producing sound ingots was described by Dr. Hans Goldschmidt, who claims for it favourable results with thousands of actual ingots. This method consists in the introduction into the central, fluid part of a partially solidified ingot of a cartridge of "thermit." The amount of thermit used is small—about one pound per ton of steel—so that the heat generated is strictly local and quite negligible. The introduction of the thermit cartridge, which consists of an iron canister pushed down with an iron rod, results in a boiling or frothing up, followed by a settling of the steel in the mould, this shrinkage being made good by the addition of a further small amount of molten steel from the ladle. The author suggests that the thermit reaction taking place near the bottom of the solidifying ingot results in the removal of gas and of entangled slag, but this point of view was not at all appreciated in the discussion; in fact, Dr. Goldschmidt's proposals were scarcely taken seriously. Thus Stead suggested that the addition of a small amount of aluminium to the steel in the ladle would produce the same effects—a suggestion strongly repudiated by Goldschmidt. In view of the large amount of practical evidence brought forward in the paper, this treatment was a little surprising.

In the course of the discussion on these papers, Dr. J. E. Stead described a method introduced by Talbot for the production of sound ingots. In this process the ingots are passed through the "cogging mill" before their interior portions have become solid, and in this way the wider end of the ingot is compressed and the liquid steel is forced to fill up any shrinkage cavities which might be in course of formation. In principle this process is similar to the Harmet method of compressing steel ingots during their solidification, but if it proves to be practicable to handle and lightly roll ingots consisting of molten steel with a mere external crust of solidified metal, the method may justify the enthusiastic predictions of its sponsor. Talbot's own account of his procedure, with the statistical data demanded by Hadfield, will, however, be awaited with interest.

Among the more scientific papers which were taken as read at the meeting, the most interesting from the general point of view is that of Benedicks on allotropy in general and that of iron in particular. In this paper the author begins by raising the question whether allotropic or polymorphic changes are necessarily sudden, *i.e.* whether they must occur at one definite temperature or whether they may in certain cases occur continuously over a certain range of temperatures. He arrives at the latter conclusion, and expresses it by saying that all degrees of mutual solubility of the two allotropic modifications in one another are theoretically possible. In the case of a considerable mutual solubility an allotropic "transformation point" would cease to exist, but where the solubility is one-sided, the modification ii. being slightly soluble in the modification i., but not *vice versa*, there would be a gradual change upon one side of the transformation point with a large sudden change at that point itself. By means of accurate dilatometric measurements on silver iodide, Benedicks shows that the transformation of this body is of the type just indicated, the curve of dilatation giving the precise shape required on the assumption that the high-temperature modification is to some extent soluble in the low-temperature modification at temperatures just below the transition point, the solubility decreasing with falling temperature. This accounts for the negative dilatation at room temperatures.

When this view is applied to the case of iron, the author considers that the critical point at or near 890° C. is a definite allotropic change-point, but he does not regard beta iron as a separate allotropic form, explaining the existence of the beta range on the basis that gamma iron is soluble in alpha iron to an extent which increases with the temperature until the critical point is reached. Benedicks considers that this view would greatly simplify the metallography of iron, since it would reconcile the three theories now accepted as most probable regarding the nature of martensite. This interesting paper would undoubtedly have given rise to one of those spirited discussions for which this particular subject is noted, and it is a pity that so important a communication should have been passed over; it may be hoped, however, that it will receive full attention in the discussion by correspondence which forms so interesting a feature of the Journal of the institute.

HEREDITY AND EUGENICS.

THE third and last number of *The Mendel Journal* contains an interesting article on the alternative heredity of mental traits, by Dr. Frederick Adams Woods, of the Massachusetts Institute of Technology. Dr. Woods's previous studies of heredity as exemplified in Royal families attracted a great deal of attention, and the present short paper based on the same class of material is well worthy of study. He advances the argument that the contrasts shown in the characters of children born of the same parents and brought up in the same environment are evidence for, and not against, the inheritance of mental traits. Those who would insist, as many do, that psychical characters are wholly the expression of the environment will find these contrasts very difficult to explain, but to their opponents who attribute the preponderating influence to heredity they present no difficulties, since the possibility of alternative inheritance has never been disputed. Among the other contents of the number is an article on primitive eugenics, by Mr. E. Torday, in which the eugenical value of the customs of certain central African tribes is pointed out and their good effects described.

The American Eugenics Record Office was founded in 1910, and is now well established in a career of useful activity. Among its latest publications is Prof. C. B. Davenport's "Trait Book" (Bulletin No. 6).

The main object of this work is to provide an indexed and classified list of mental and physical traits to assist, by enlarging their vocabularies, the "field-workers" employed by the office in the collection of data for the study of inheritance in man. A decimal system of classification is adopted. Simple numbers denote the primary classes and additional numbers are added to represent successive stages of subdivision; for example, 4 stands for mental traits, 45 special abilities, 459 special ability for athletics, 4595 for ball playing, and 45954 for golf. The classification does not appear to be always logical; thus after 46 is written "egoistic (temperament)," and after 4622 "optimism *vs.* pessimism," something different in kind to, and not a subvariety of, egoism. Not only field-workers, but others, even lexicographers, will find in this pamphlet additions to their vocabularies, but it is doubtful whether many will desire to use such words as "unanecdoteness" or "unconversationableness." Further, we would question the propriety of contrasting "ludicrousness" with "absence of sense of humour," as a sense of humour is the faculty which most effectively enables one to avoid being ludicrous. But though these and other criticisms might be made, the work is one of undoubted utility, and will no doubt be greatly improved in future editions.

E. H. J. S.

INFLUENCE OF GEOGRAPHICAL CONDITIONS UPON JAPANESE AGRICULTURE.

IN a paper read recently before the Royal Geographical Society, Miss E. C. Semple discussed, largely on the basis of personal observation, a number of interesting features in the influence of geographical conditions upon Japanese agriculture. Premising that islands, with climates rendered equable by marine influence, and with the further advantage of supplying "the double larder of land and sea," offer specially favourable conditions for the early development of civilisation, she showed that agriculture in such circumstances quickly becomes intensive owing to the demand of an expanding population upon a cultivable area which, being insular, is not capable of expansion. This condition is particularly marked in Japan, because to its insular character are added other contributing causes. Cultivation and settlement are rare above about 2300 ft. of elevation. Forests and barren highlands above this height clearly segregate the densely populated valley-settlements, which cling closely to the rivers and streams, where rice, the staple crop, may receive the necessary irrigation.

Moreover, it is not merely what may be termed the mechanical facilities for this cultivation which limit its distribution. The generally unfertile character of the soil has also to be taken into account. Miss Semple quoted the present percentage of arable land to the total area of Japan proper as only 14·37, and proceeded to show that so far as statistical data are available, only Finland, Sweden, and Norway show a smaller percentage, and these, unlike Japan, are sparsely populated countries. The reclamation of the unfertile and ill-watered wastes, and the diversification of crops, are beyond the means of the Japanese smallholder, though a few rich farmers or companies have undertaken such work.

In dealing with the fertilisation of the soil, Miss Semple adverted to "the practical absence of stock-raising." It has been sought to attribute this peculiar feature to the principles of the Buddhistic faith, but Miss Semple prefers to find its reason in the scarcity of natural pasturage or fodder-plants. She dealt at some length with the two classes of wet and dry fields characteristic of Japanese agriculture, together with the geographical effect of relief upon their distribution; on the other hand, she showed that the terrace system of cultivation usually associated with mountainous tracts alone is not so in Japan, because the irrigation of the lowland rice-fields also involves it. The raising of the silk-worm is found to be practically confined to inland provinces, and largely to upland farms, where communications are bad, and the natural tendency has been to develop a product of small bulk (and therefore easily conveyed) and high proportional value.

CHEMISTRY AT THE BRITISH ASSOCIATION.

THE Chemical Section may claim a fair share in what has proved to be a record year for the Association generally, and although the counter attractions of the International Congress had some effect on the attendance of the senior chemists, the section room was better filled than has sometimes been the case of late years. In particular Prof. Divers was greatly missed; for many years there has been no more regular supporter of the Association.

Whilst the plan adopted of grouping communications more or less under four main headings had the result that, as regards quality, the discussions were the best for some years past, this plan has the disadvantage that it tends to emphasise the very special nature of the subjects considered. The type of paper presented was satisfactory: brief summaries of the field rather than detailed accounts of method and results were the rule, and in consequence the task of the president in keeping to the time table was a light one.

The daily Press is apt to criticise the work of the section as too technical, but it must not be forgotten that the problems which chemists are now engaged in studying are essentially of a fundamental character. Dundee will perhaps be remembered as the "origin of life" meeting, and though the discussion on this subject was confined to the biologists, both in this discussion and in Prof. Schäfer's address it was admitted that chemical science must be looked to ultimately for light on the problems of life.

In acquiring accurate knowledge of the carbohydrates, fats and proteins, or of the properties of colloids, or in the study of enzymes and cell activators of all kinds, the chemist has already amassed a greater store of exact knowledge of biological import than is generally realised. Though he is forced at present by their very complexity to surround his conceptions in the technicalities of a nomenclature, which to the initiated is unique in its expressive simplicity, the day is not far distant when a more popular summary will be possible—indeed, only this year the announcement has been made of the success of nutrition experiments carried out entirely with synthetic food, every ingredient of which can be built up chemically from the elements.

The proceedings on Thursday, September 5, opened as customary with the presidential address, which has already appeared in full, the rest of the morning being devoted to physical papers. Prof. H. Marshall described the interaction between thiocarbamide, iodine and sulphur. Mr. A. J. Berry dealt with the distillation of binary mixtures of metals *in vacuo*, and described experiments showing that copper and cadmium are quantitatively separable by volatilisation of the cadmium, whereas magnesium and cadmium yield a non-homogeneous distillate. The compound $MgZn_2$ can be prepared by distilling alloys containing an excess of zinc beyond this composition; the excess of zinc volatilises.

Dr. C. H. Desch gave a brief summary of a very full report he has prepared on diffusion in solids, which was in print before the meeting. The final conclusion is that the occurrence of diffusion in metals is established beyond any doubt, but that experiments are still lacking to prove its occurrence in transparent crystals of minerals, salts, or organic substances. The report deals with diffusion in glass, the passage of gases through metals, and particularly with diffusion in solid metals, including cementation and decarburisation of iron. Dr. Holt followed with a paper on the sorption of hydrogen by palladium, in which he described his own recent experimental work.

The next paper, by Mr. R. de J. Fleming-Struthers, dealt with nitrogen chloride in relation to photochemical inhibition. When nitrogen chloride vapour, mixed with an indifferent gas, is heated, no change is perceptible until the temperature reaches a certain value; then suddenly decomposition begins and appears always to culminate in an explosion. Explosion likewise occurs in an atmosphere of hydrogen, but in this case an interaction sets in, and ammonium chloride is precipitated. When a similar mixture is exposed to the action of light, only very little of the nitrogen chloride is converted into ammonium chloride, showing that practically all the nitrogen chloride is decomposed by light before any hydrogen chloride can be formed. Nitrogen chloride is an inhibitor of combination between chlorine and hydrogen on exposure to light, and is capable of producing a period of inaction comparable to Bunsen and Roscoe's induction period.

Mr. A. Fleck gave an account of a careful chemical examination of Marckwald and Keetman's statement that thorium and uranium X could not be separated. This has been confirmed, the method chiefly used in the attempted separation being fractional precipitation. It was found impossible to alter the concentration of the short-lived radio-active element in thorium. Similarly radio-actinium and thorium, also thorium B and lead, were found to be two pairs of chemically inseparable elements.

A paper by Prof. Stock (Breslau) and Dr. G. E. Gibson on the dissociation of phosphorus vapour may be referred to here, though it was read on the Monday. The authors have determined the pressure temperature curves of phosphorus vapour at various volumes, using quartz apparatus and a new form of quartz membrane manometer devised by Gibson. Up to 700° C. the vapour density corresponds to the formula P_4. Above this, dissociation takes place according to the equation $P_4 = 2P_2$.

On the Friday the section joined with the botanists to discuss questions of chemical variation in plants and the nature of plant pigmentation.

Dr. J. V. Eyre gave an account of work carried out with Prof. H. E. Armstrong on the enzymes and glucoside of flax. The glucoside linamarin is constantly present in the green plant and in the unripe seed of flax; in consequence, hydrogen cyanide can usually be detected in commercial linseed cake. Ripe seeds are free from cyanide, but since flax flowers during a considerable period, the seeds are never ripe all at once. In extreme cases the amount of hydrogen cyanide may be sufficient to be harmful, but it is also probable that it is of positive condimental value, and that the special value of linseed cake as a cattle food may be due in part to the liberation of minute proportions of hydrogen cyanide.

In addition to common flax, a wide variety of Linaceæ have been tested; only the white, blue, or red-flowered varieties contain the glucoside, which is entirely absent in all the yellow flowering species examined. Dr. Eyre also gave an account of the variations in the flax plant with locality, flax being a plant which rapidly becomes adapted to new conditions. Seed taken from a blue flowering crop is commonly stated to give a crop of flax bearing white flowers when raised under different conditions of climate. A number of similar instances of degeneration were noted. In the discussion Prof. Bateson expressed the opinion that it should not be difficult to select a type of flax which would breed true for any desired qualities. Probably the commercial seed was impure, so that under changed conditions a previously minor constituent of the mixture was unduly favoured. This would account for much of the variation mentioned.

Prof. Armstrong gave an account of the variation of glucoside and enzyme in *Lotus corniculatus*, which has been studied over a wide area. The glucoside of this plant contains hydrogen cyanide, and is probably identical with that present in flax. Whereas in 1910 plants collected near Reading contained the glucoside, it was, as a rule, missing from plants gathered in other localities. During 1911 cyanide was found uniformly present in plants from different parts of England, but it was frequently absent in specimens from the west of Scotland and from Norway. Variation in the age or habit of the plant or in the nature of the soil had no effect on the presence of cyanide. The glucoside was always accompanied by the appropriate enzyme, whereas in the allied species *L. major* neither enzyme nor glucoside ever occur. This paper was very fully discussed by Prof. Bateson and the botanists present, and it was regarded as a significant case of chemical variation in plants which requires further study.

A joint paper on the biochemistry of plant pigmentation by Prof. F. Keeble and Dr. E. F. Armstrong was read by the latter, who gave a general summary of the subject from the chemical side, supplementing that contained in the presidential address to the botanists. It is probable that the soluble sap pigments of plants are formed by the action of an oxydase on a colourless chromogen, which has first to be liberated by the appropriate enzyme from its combination with glucose. It is possible that amino-acids or other protein degradation products take part in the interaction, and that this variable factor accounts for the differences in shade. Methods were described which enable the exact localisation of the oxydases in plant tissues, either macro- or micro-chemically, without any far-reaching breakdown of the cellular structure taking place. It has been possible to show in the clearest manner possible that the localisation of these oxydases in plants agrees closely with that of the colour.

Oxydases, according to current theory, are supposed to consist of two constituents—a peroxydase and an organic peroxide. Normally the occurrence of the latter is rare, but the authors produced evidence to show that it increases in amount when a plant is kept in the dark. After such treatment it can be detected in plants from which it was formerly absent. The amount of peroxydase is also increased during the night. These observations give a clue to some of the phenomena of periodicity in life.

Attention was also directed to the chemical identification and study of the inhibiting factors in plants and animals to which Mendelians attach so much importance.

Besides the oxydases measured by the authors' methods, evidence is obtained that others are present in plants which may or may not be different. Such become prominent when the plant is wounded or treated with chloroform, with the result that browning or blackening takes place. Evidence is being accu-

mulated as to the nature of oxydases, more particularly whether they are to be regarded as enzymes.

A further contribution from the Reading laboratory by Mr. W. N. Jones dealt with the distribution of oxydases in white flowers. Many white flowers contain a chromogen which becomes coloured (brown) when acted upon by an oxydase or peroxydase. The author considers that this chromogen is probably not identical with that responsible for the colour in the flower of coloured varieties of the same species. The chromogen may be associated with oxydase or with peroxydase only, or it may be altogether lacking from the flower. It is possible to extract this chromogen after destroying the oxydase by boiling, and use the solution as a test for oxydase in the same way as benzidine.

A paper by Mr. A. Compton gave a summary of Prof. Bertrand's investigation of the action of enzymes on the complex glucoside vicianin, a constituent of *Vicia angustifolia*, a rare species of tare.

On Monday, September 9, the section divided, the physical chemists taking part in a joint discussion with Section A, opened by Dr. F. A. Lindemann, with a paper on the atomic heat of solids. This is reported more appropriately in the proceedings of Section A. The organic chemists devoted the morning entirely to the subject of carbohydrates. It is a remarkable fact that in spite of the great importance of the sugars as foodstuffs and the part they play in plant and animal economy, our knowledge of them is still of the scantiest. The complexity of the sugar molecule and the experimental difficulties which beset the worker in this field render progress but slow, and any researches, even if they be of the type classed by scoffers as compound making, will be of the utmost value if they serve in any way to indicate new methods of attacking the subject or lead to greater certainty of the knowledge of chemical structure. The problems of the sugars are certainly quite as complex as those of the proteins; their solution must be accomplished before any real attack is made on the origin of life.

Three communications were received from the St. Andrews laboratory. The first, by Prof. Irvine and Mr. A. Hynd, dealt with synthetic aminoglucosides. Aminoglucose, or glucosamine, as it is usually called, constitutes the simple unit which, when polymerised, forms chitin, the horny constituent of the shell of the lobster, and which occurs in place of cellulose in the cell walls of many of the lowly organisms. Hitherto the properties of glucosamine have been but little investigated. Some of the experimental difficulties have been overcome now by the use of bromotriacetylglucosamine, which enters into reaction with widely different types of hydroxy compounds. The 2-aminoglucosides thus obtained correspond with amino derivatives of the natural glucosides, which exist in such diversity in plants. Many of the synthetic substances are not simple amino compounds, but their nitrogen atom is associated with the contiguous oxygen atom to form a four-membered betaine ring; they are thus brought into relation with the betaines of plants. Others, again, particularly those in which a benzene grouping is present, do not show this peculiarity of ring formation. This paper gave rise to a full discussion.

In the following paper, by Prof. Irvine and Miss B. M. Patterson, an account was given of the experimental study of the constitution of mannitol triacetone. It is impossible to arrest the condensation of mannitol with acetone at intermediate stages, but by carefully regulated hydrolysis the acetone molecules can be removed in stages. The constitution of the intermediate compounds was determined by methylation and subsequent hydrolysis. The acetone residue is shown to be attached through oxygen to two contiguous carbon atoms, but the order in which the acetone residues were removed was quite unexpected. It is impossible to discuss the problem without entering into complex stereochemical considerations, but as a result of the work and the methods used in it, a deeper insight has been gained into the sugar molecule than had previously been the case.

The third paper, by Prof. Irvine and Dr. J. P. Scott, dealt with the rotatory powers of partially methylated glucoses. By applying stereochemical considerations based on the optical rotatory power of the isomeric glucoses and glucosides, configuration formulæ for the α and β isomerides have been deduced which are in agreement with those previously suggested by E. F. Armstrong. Certain regularities in the rotatory power of the α and β forms of the partially methylated glucoses were pointed out: these conform to the rule postulated by Hudson.

Dr. W. S. Mills described a simple method of preparing acetyliodoglucose, a compound which has in the meantime been prepared by Fischer in another way. By the action of copper hydride on this, a crystalline compound has been obtained which is considered to be the acetyl derivative of a diglucose, in which, however, the two molecules are united through carbon, and not through oxygen as in the natural sugars.

Dr. Harden followed with a summary of the knowledge of hexose phosphate, which, as his researches have shown, plays so important a part in the phenomenon of alcoholic fermentation. Dr. Harden discussed the equations which have been suggested to explain the action of the phosphate during fermentation: he was inclined to accept that which involves the rupture of glucose into two three-carbon compounds, one of which is further broken down into carbon dioxide and alcohol, whilst the other unites with a similar compound from a second molecule of sugar to form hexose phosphate.

The sitting concluded with a paper on nomenclature by Dr. E. F. Armstrong. It is suggested to number the six carbon atoms in glucose thus:—

$$\overset{6}{C}H_2OH.\overset{5}{C}H(OH).\overset{4}{C}H(OH).\overset{3}{C}H(OH).\overset{2}{C}H(OH).\overset{1}{C}HO,$$

instead of using Greek letters as at present. This avoids the confusion arising from the common use of α and β to indicate isomerism in the groups attached to the asymmetric carbon atom in position 1. Prof. Irvine concurred in this suggestion. Attention was also directed to the uncertainty introduced in the nomenclature of optically active compounds by using the prefixes *d* and *l*, sometimes to denote the sense of the rotation and sometimes to denote the relationship in configuration to *d*-glucose.

The greater part of Tuesday's proceedings were devoted to papers dealing with subjects of importance to organic chemists—namely, the migration of groups and the laws of substitution in the benzene ring.

The methods by which chemists are wont to determine the structure of a compound and the precise position in it of certain groups all depend on the displacement of this group by another at some stage of the investigation. It is important to know that such substitution takes place in a simple manner, and that the new group is not introduced in some altogether different position. Unfortunately for our theories, it was found by Walden some few years back that in the case of optically active compounds such rearrangement is the rule rather than the exception. In consequence, when some new compound is obtained from an optically active substance, it is fre-

quently impossible to say whether the substance formed is the desired compound or its mirror image. The mechanism of such interactions has been fully studied by E. Fischer in Berlin and A. McKenzie in London, and it was appropriate that the latter should give a concise though clear and logical summary of the question, which is generally spoken of as the Walden rearrangement, before the section. A considerable discussion ensued.

Dr. Lowry followed with a paper dealing with a closely allied subject, that of isomeric change, and more especially with those taking place in solutions of the crystalline amide and piperidide of camphor-carboxylic acid. This case is of exceptional complexity, since the experimental measurements show that three distinct isomeric changes take place, and that a condition of equilibrium is established ultimately between four distinct isomerides. The equations for consecutive unimolecular changes of this type were described at length, as well as the curves representing change, and they were afterwards discussed by Prof. Soddy and others.

The second part of Dr. Lowry's communication dealt with the use of certain models to explain Barlow and Pope's theory of molecular structure based on valency conceptions. A very fluent account was given of a difficult subject, which was closely followed by those present.

The next two papers, by Prof. K. J. P. Orton, of Bangor, and Prof. Holleman transferred attention to the laws of substitution in the benzene series. Prof. Holleman's status in this field is well known, and the section was fortunate in having his cooperation throughout the meeting. Prof. Orton dealt with the conversion of chloro-, bromo-, and nitro-aminobenzenes into the carbon substituted anilines and anilides, giving a detailed account of his recent work. Prof. Holleman described work carried out in conjunction with Mr. J. P. Wibaut on the nitration of the chlorotoluenes. He indicated the number of isomerides formed in the various cases, and showed both how to calculate approximately their proportions and how well these figures agreed with those determined experimentally by the laborious separation of the constituents of the mixture.

A brief communication by Dr. J. K. Wood, who acted as local secretary for the section, was of considerable interest. Leucine and similar amphoteric substances are in reality internal salts, the acidic and basic groups neutralising each other. When an acid or base is added, the internal salt is broken up and a true salt formed with the added acid or base. In the case of an optically active substance it should be possible to determine the rotation when the whole of the internal salt has just been broken up, and so calculate the acidic and basic constants of the amphoteric substance. Leucine is lævorotatory in aqueous solution, but on the addition of hydrochloric acid the solution becomes increasingly dextrorotatory. When about 1·34 equivalents of acid have been added, the effect of further addition is much smaller, and there is a sharp bend of the curve at this point corresponding with the complete disappearance of the internal salt.

Equally sharp results could not be obtained with sodium hydroxide, owing to racemisation being caused by the alkali.

The method can be used at all events qualitatively to measure the strength of the added acids; the weaker the acid the more concentrated it must be to break up the internal salt. By working with a common acid, various amphoteric substances may be compared.

Owing to the shortness of time, Prof. C. R. Marshall gave a very brief account of the two papers standing in his name. The action of bromine on strychnine has been investigated with the object of preparing a dibromo compound as described by some authors, but this does not appear to exist. The second paper dealt with pentaerythritol tetranitrate.

The final communication on phototropy was delivered by the president, who showed specimens of phototropic compounds obtained in the course of investigations on salicylidene amines. Of a large number of such compounds examined, fourteen have been found to exhibit phototropy distinctly—that is, they change in colour on exposure to light. In studying the influence of temperature on the phenomenon, it has been found that while some are phototropic at temperatures up to their melting points, others have a limiting temperature, above which they are not phototropic, whilst in two cases compounds which are not phototropic at the ordinary temperature show this property below zero centigrade.

The explanation of phototropy is still outstanding; it has been considered in turn as due to intramolecular rearrangement, stereoisomerism and polymorphism. Another problem is the nature of the energy evolved when the darker-coloured phototrope in the absence of solar energy, or possibly also when under solar influence, returns to the lighter form: this remains for future investigation.

A novel and successful feature of the meeting on its less severe side was the sectional supper held on the Saturday. E. F. A.

THE DIFFUSION OF EDUCATION AND KNOWLEDGE.[1]

THE educational status of a nation consists in the amount of literacy, number of teachers, and number of persons in its primary and secondary schools, and in its colleges and universities, relative to population. The status of knowledge may be indicated by the number of books, periodicals, and newspapers relative to population. This knowledge may take two forms, one gained through books, the other through periodicals and newspapers. One is knowledge in general; the other consists more in current information.

The question may be asked, if a community or country leads another in literacy, diffusion of education and knowledge; if, relative to its population, it has more pupils in school, more teachers, more students in colleges and universities, more books in its libraries to read, and more periodicals and newspapers to peruse, is not this country or community, as a whole, very probably better educated and more intelligent than the other country or community? While there are exceptions due to special conditions, we are disposed to answer this question in the affirmative.

Table I. indicates in a general way the diffusion of education and knowledge in some leading countries.

Column 1 gives the relative amount of illiteracy among army and navy recruits. As these are mostly adults, they probably represent best the real amount of illiteracy. Column 6 gives the number of publications (relative to population) in the list of the Smithsonian Institution in Washington. These publications are of the highest class, including journals issued by learned societies and governmental institutions.

Examining Table I., it will be seen that Switzerland is much in advance of all the other countries in general diffusion of education and knowledge, and

[1] From a paper on "Mentality of Nations in Connection with Patho-Social Conditions," by Arthur Macdonald, in *The Open Court* for August.

Russia is last. Italy also is very low in these respects. France shows a high degree (next to Switzerland) of diffusion in university education (81) and newspaper information (251). Germany shows the lowest degree of illiteracy and publishes the largest number of books, but not relative to its population. Denmark issues the largest number of books relative to population.

The United States, compared with European nations, is next to highest (Switzerland) in number of newspapers issued, but next to lowest (Russia) in number of university students enrolled and books produced, relative to population.

Since we are disposed often to estimate countries as to their mental status or literary production without reference to their population, we will compare the countries in Table I. according to the absolute number of books, periodicals, and newspapers published, as given in columns 7, 8, and 9.

Denmark, which is behind France, Great Britain, and the Netherlands. There is no further correspondence of these three highly literate countries in the other educational columns.

In brief, there appears to be but little necessary relation in these countries between degrees of education and amount of literary production. Thus, Italy, with its great illiteracy, stands very high in university education. This is interesting in connection with the fact that Italy is doing some of the best work in sociology, which is suggestive in connection with the further fact that she stands next to the highest in production of sociological works.

The United States has a large percentage of illiteracy, yet ranks highest in percentage of population enrolled in schools, but has the smallest number of university students. It has next to the largest number of newspapers, but produces next to the

TABLE I.

Country 1908	Education			Knowledge and information					
	Number of illiterates per 10,000 recruits	Per cent. of population enrolled in schools	Number of university students per 10,000 population	Number of newspapers per million population	Number of books published per 100,000 population	Smithsonian list: Number of publications per million population (1904)	Number of books published	Number of newspapers and periodicals issued (year)	Smithsonian list: Number of publications (1904)
Column	1	2	3	4	5	6	7	8	9
Belgium	833[1]	12·2	68	27	28	48	2763	209 (1908)	354
Denmark	20[2]	13·0	—	84	135	42	3519	220 (1908)	112
France	346[1]	14·2	81	251	28	42	8799	9877 (1908)	1723
Germany...	4[1]	17·0	65	115	49	39	33317	7000 (1907)	2390
Great Britain and Ireland	100[1]	17·0	56	98	22	45	9821	4400 (1905)	2038
Italy	3072[3]	8·1	77	60	21	24	6918	2067 (1904)	834
Netherlands	210	15·0	72	132	56	36	3258	760 (1906)	207
Russia	6110[4]	4·5[5]	16	8	—	3	23852	2220 (1905)	515
Switzerland	9	18·6	178	275	116	90	4256	1005 (1907)	351
United States...	380[6]	19·7	20	260	10	—	9254	21320 (1908)	—

[1] 1904. [2] 1897. [3] 1903. [4] 1895. [5] 1907: in 1907, 39 per cent. of males and 27 per cent. of all persons (9 years of age and more) were able to read. [6] In white male population 21 to 24 years of age in 1900.

As to largest number of books the rank is Germany, Russia, Great Britain, United States, France, Italy, Switzerland, &c.

As to number of newspapers and periodicals, United States is unique, publishing twice as many as France (next in rank), and from three to ten times as many as some of the other countries.

As to the Smithsonian list of publications, the rank is Germany, Great Britain, France, Italy, Russia, Belgium, Switzerland, &c.

If we take the extremely illiterate countries, as Russia, Italy, and Belgium, we find a correspondingly low percentage of the population enrolled in the public schools and a relatively low percentage of newspapers published. But when we come to the number of university students enrolled, the correspondence fails as to Italy and Belgium, which have, relative to population, a larger number of university students than Germany or Great Britain. As to the number of books published relative to population, the correspondence fails in the case of Belgium, which produces as many books as France (column 5), relative to its population. As to the Smithsonian list of publications, the correspondence fails in the case of Belgium, which is next to the highest (column 6).

If, now, the countries distinctly the least illiterate, as Germany, Switzerland, and Denmark, are compared in respect to enrolment in schools or primary education, the correspondence fails in the case of smallest number of books. Russia, about which data are more difficult to obtain, stands lowest in all respects relative to its population.

Different countries naturally do not classify books in the same way, and sometimes one country will include under one head publications that other nations would place under another subject, and hence results given in Table II. must be taken in a general way.

In order to render the table more trustworthy, we have included two or more subjects under one head. For instance, under "History," both "Biography" and "Geography"; under "Literature," "Poetry," "Fiction," and "Drama," and under "Religion," "Theology." "Fiction" is both put by itself and also combined with "Literature."

A few headings could not be classified nor combined with others and were omitted, so that the table is not complete, but the percentage for each subject given is, of course, not affected.

It may be interesting to note the kind of books some countries prefer, as shown in Table II. Thus, France publishes relatively more medical works (10·5) than any other nation here mentioned. Italy is second (7·6) and Germany third (5·8) in this subject. Belgium publishes relatively the most law books, Denmark the fewest. United States, Denmark, and Germany lead in religious works. Denmark and France excel in literature, and Germany and Italy in educational works, and France in books on military science.

TABLE II.—*Book Production—Per Cent. for Each Subject.*

Country 1908	Medicine	Law	Philosophy	Religion	History	Sociology	Literature	Education	Art	Science	Military science	Fiction
Belgium	5·7	7·0	2·6	3·8	13·4	8·6	17·3	3·8	6·2	7·0	1·1	—
Denmark ...	3·7	1·1	1·2	9·6	—	—	23·2	3·3	2·2	9·7	—	—
France	10·5	6·3	2·1	7·3	17·3	6·4	22·0	11·4	1·2	4·5	3·9	—
Germany... ...	5·8	10·0[1]	2·3	8·4	9·0	10·0[1]	19·5	13·8	2·9	5·7	2·3	13·7[4]
United Kingdom	3·1	2·6	—	9·5[2]	13·9	6·7	18·4	6·4	—	11·8	—	2·6
Italy	7·6	4·9	2·8	4·4	12·0	6·7	14·1	13·1	2·6	5·8[3]	1·9	6·3
Netherlands ...	3·3	5·3	—	6·2	—	5·3	—	9·3	—	5·3[3]	—	—
Russia	4·6	3·1	—	6·8	3·0	—	10·2	7·9	—	2·5	—	—
United States...	3·6	9·9	1·9	8·8	14·7	5·9	13·3	4·5	2·5	5·1	—	16·0

[1] Law and political science. [2] Religion and philosophy. [3] Science and technology. [4] Belles lettres.

Although correspondence between mental and pathosocial conditions, or concomitant relations, does not necessarily indicate causal connection, yet it is interesting to note a few instances. In general, those countries which have the greatest illiteracy, as Italy, Belgium, and France, show the highest percentage of murder. They also have a high percentage of still-births, death-rate, and death-rate under one year of age. Two of these countries, where the illiteracy is more pronounced, as in Italy and Belgium, show a low rate of suicide and divorce. On the other hand, the least illiterate countries, as Germany, Switzerland, and Denmark, have a high rate of suicides.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

BIRMINGHAM.—The chair of midwifery recently vacated by Dr. Edward Malins has been filled by the appointment thereto of Dr. Thomas Wilson, who has previously held the post of lecturer in this subject.

CAMBRIDGE.—Prof. R. C. Punnett has been selected by the Prime Minister and Mr. A. J. Balfour as the first Arthur Balfour professor of genetics.

A prize of 50*l.* out of the Gordon Wigan Fund will be awarded at the end of the Easter term, 1913, for a research in chemistry, of sufficient merit, carried out in the University of Cambridge. The research may be in any branch of chemistry. The dissertation, with the details of the research, must be sent to the professor of chemistry not later than June 13, 1913.

The current number of *The Reporter* contains revised schedules of the special examination in geography for the ordinary degree, and for the examination for the diploma in geography. It also contains the list of subjects for the special examination in military subjects for next year.

OXFORD.—On November 19 Convocation will be asked to assent to a decree providing that a plot of land on the south side of the University Park, and another plot at the north-west angle of the park, be assigned for the purposes respectively of a chemical and an engineering laboratory. It is possible that the proposals will meet with opposition, as many members of the University are averse from further encroachments on the space available for recreation. At a later date statutes will be submitted to Congregation amending the present constitution (1) of the Hebdomadal Council by abolishing the existing division into "Orders" of its elected members, and (2) of Congregation, by abolishing the present qualification of residence, and enacting that in future Congregation shall consist of the teaching and administrative elements in the University and colleges. Another proposed statute provides, in certain circumstances, for a poll of Convocation to be kept open for three days. It is thought that the second at least of these proposals, *i.e.* that relating to Congregation, will be resisted.

The election to a fellowship at All Souls' College of a graduate distinguished in mathematics or natural science is a rare occurrence, hence it is specially worthy of record that Mr. D. B. Somervell, of Magdalen College, one of the latest elected fellows of All Souls', obtained honours in mathematical moderations in 1908, and first-class honours in chemistry in 1911.

The new Pharmacological Laboratory was formally opened on November 9 in the presence of the Vice-Chancellor and a large assemblage of Oxford medical graduates. The history of the department was briefly recounted by Sir William Osler, Regius professor of medicine, and an address on "The New Pharmacology" was delivered by the Reader, Dr. J. A. Gunn. Space for the new laboratory has been found by the insertion of a floor in the rooms on the west front of the museum formerly occupied by the Radcliffe Library. Of the two stories thus formed, the upper is devoted to pharmacology, the lower is shared between the Hope department of entomology and the department of mineralogy.

LIEUT.-COL. W. W. O. BEVERIDGE, D.S.O., Royal Army Medical Corps, has been appointed professor of hygiene at the Royal Army Medical College, Grosvenor Road, S.W., in succession to Brevet-Col. C. H. Melville.

WE learn from *Science* that Mr. T. W. Todd, at present lecturer in anatomy at Victoria University of Manchester, has been appointed Henry Willson Payne professor of anatomy in the medical department of Western Reserve University in the United States. Prof. Todd will take up his new duties in December.

THE sum of 10,000*l.*, free of Government duties, has been bequeathed by the late Misses Mary, Hannah, and Helen Dalgety and Mrs. Isabella Dalgety, or Wilson, to the University of Edinburgh for the foundation and endowment of bursaries not exceeding 50*l.* for two years and prizes in the law faculty of the University.

A MEETING of the governors of the South-Eastern Agricultural College, Wye, was held under the chairmanship of Lord Ashcombe, at Caxton House, on Monday, November 11. The governors considered the proposed establishment of a fruit research plantation in the south-eastern district, and decided to accept the responsibility of administering such a plantation with the aid of the grant of 500*l.* offered by the Board of Agriculture.

THE council of the City and Guilds of London Institute has conferred the fellowship of the institute upon Mr. A. Chatterton and Mr. W. D. B. Duddell, F.R.S. This distinction is extended to those students who

have obtained the associateship of the institute, and spent at least five years in actual practice, and by original and valuable research work or otherwise have contributed to the advancement of the industry in which they are engaged.

RECENTLY the faculty of medicine of the University of Giessin conferred the honorary degree of doctor of medicine upon Ernst Leitz, Junior, the junior partner of the celebrated optical firm, E. Leitz, of Wetzlar, and 18 Bloomsbury Square, London. It is only a little more than a year since the University of Marburg honoured the senior partner of the same firm by conferring upon him the degree of doctor of philosophy. It must be gratifying to the firm that its services towards science are so highly appreciated and recognised.

A JOINT conference on the Montessori system of education, arranged by the Child Study Society (London) and the Montessori Society of the United Kingdom, will be held at the Royal Sanitary Institute, Buckingham Palace Road, S.W., on Saturday, November 16. The chair will be taken at 3 p.m. by the Hon. Sir John A. Cockburn, K.C.M.G. The conference will be preceded on Friday, November 15, at 7.30 p.m., by a lecture by Madame Pujol-Segalas (of Paris) on "Maria Montessori's Method and Self-education." Mr. R. Blair, education officer of the London County Council, will preside.

THE following lectures for advanced students of the University and others interested in the subjects are announced in *The London University Gazette*. A course of six lectures on "Methods of Illumination as applied to Microscopy," at Charing Cross Hospital Medical School, Chandos Street, W.C., by Mr. J. E. Barnard, at 5 p.m. on Thursdays, beginning on November 14; and a course of three lectures, on "Recent Work in Experimental Embryology," in the Zoological Lecture Room of University College, by Dr. J. W. Jenkinson, on Fridays, November 29, December 6 and 13, 1912, at 5 p.m. Admission to the lectures is free, without ticket.

MR. A. G. WARREN has been appointed a lecturer in the engineering faculty of the University of Hong Kong. He was a lecturer in the East London College, and has been head of the engineering department of the Aston Manor Technical School, Birmingham, for the last eighteen months. In July last Prof. C. A. M. Smith (of the East London College) was appointed to the Tai Koo chair of engineering in that University, and immediately proceeded to the Far East to take up his new duties. The Hong Kong University opened its doors to students in October, 1912, and, although the equipment of the engineering department had not then been commenced, there were thirty-five engineering students who passed the entrance examination, and who now form the first-year engineers of the latest British university. It is interesting to record the fact that these Chinese engineering students have come from many different parts, and include some from Straits Settlements, Canton, and Foochow.

VARIOUS changes are proposed in the regulations for the examinations for certain junior appointments in the Civil Service. The age limits for the appointments being eighteen to nineteen and a half years, they are as a rule competed for by candidates from secondary schools. Certain subjects in the examination are compulsory; while the optional subjects are divided into two classes, the papers in one being of a lower standard than those in the other, and consequently receiving only half the marks of the higher papers. At present, papers of lower standard are set in mathematics, French, German, Latin, Greek, English history, chemistry, and physics; and higher papers are set in mathematics, French, German, Latin, Greek, English and European history, chemistry, and physics. It is proposed in 1914 to set a lower paper in European history in addition to the subjects named above, and no longer to set higher papers in history, chemistry, and physics. It is clear that the proposed change will operate unfavourably against schools where two classical languages are not taught, and against candidates whose abilities are scientific rather than linguistic. We are glad to notice that the Education Committee of the London County Council has passed a resolution to this effect, which is being sent to the Civil Service Commissioners for their consideration.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Anthropological Institute, November 12.—Dr. A. P. Maudslay, president, in the chair.—R. W. **Williamson**: The Mekeo people of New Guinea. Mr. Williamson gave an account of the Mekeo modes of courtship and ceremony of marriage. For the former, love charms and philtres are extensively used, and the rising sun is appealed to for help. The negotiations for the marriage involve substantial gifts by the boy's family to that of the girl, including ornaments, &c., which are presented at the time of the negotiations, and pigs, which the girl's relatives afterwards secure by means of a mock hostile raid upon the boy's clan. The author also described some of their ceremonial dances, which he believed to have an origin in an imitation of the dancing movements during the courting season of the goura pigeon, and elaborate ceremonial performances, at which much coveted decorations are bestowed upon warriors who have slain an enemy in battle; also their funeral and mourning ceremonies, the former of which includes a comic feast and a game of "bob-apple"—the apple being the leg of a pig or kangaroo.

PARIS.

Academy of Sciences, November 4. M. Lippmann in the chair.—G. **Bigourdan**: The International Time Conference. The first meeting was held at Paris on October 15, and was attended by the representatives of fifteen Governments. The work was subdivided amongst four subcommittees, and a detailed account is given of their conclusions and suggestions.—Paul **Appell**: The theorem of the last Jacobi multiplier connected with the formula of Ostrogradsky or Green.—L. **Maquenne** and E. **Demoussy**: The determination of respiratory coefficients. A discussion of the relations between the apparent and true respiratory coefficients when determined in a fixed volume of air.—W. **Kilian** and Ch. **Pussenot**: The age of the shining schists of the Franco-Italian Alps. There is a break in these strata, a portion being Mesozoic and another part Tertiary. These two portions are probably stratigraphically discordant.—Kr. **Birkeland**: The origin of planets and their satellites. From experimental considerations the author has been led to the view that in solar systems in course of evolution there exist forces of electromagnetic origin of the same order of magnitude as that of gravitation. The retrograde revolution of the recently discovered moons of Jupiter and Saturn is in accordance with this view.—MM. **Fayet** and **Schaumasse**: The elliptic elements of the 1912*b* comet (Schaumasse comet): its identity with the Tuttle comet.—P. **Idrac**: Spectroscopic observations of the Gale comet (1912) made at the Meudon Observa-

tory. The photographs showed the usual comet spectrum, with hydrocarbon and cyanogen lines.—M. **Borrelly**: The discovery and observation of the comet 1912*c*, made at the Observatory of Marseilles. The comet is of 9·5 magnitude, 2′ in extent, round, with a nucleus and without a tail. Its positions are given for two observations on November 2.—Michel **Plancherel**: The problems of Cantor and of Dubois-Reymond in the Legendre theory of series of polynomials.—G. **Ribaud**: The spectrum of magnetic rotation of bromine. The Righi effect has been studied with more powerful magnetic fields, up to 24,000 Gauss. The re-establishment of the light observed longitudinally in the magnetic field cannot be attributed to a Zeeman effect; all the absorption lines of bromine show the phenomenon of magnetic rotatory polarisation, on condition that for any given line a suitable vapour pressure is chosen. The appearance of the magnetic rotatory spectrum changes completely when the pressure is altered.—Léon and Eugène **Bloch**: The ionisation of gases by the Schumann rays. Ordinary sources of ultra-violet light placed in air emit a considerable proportion of rays sufficiently refrangible to be partially absorbed by quartz, and brass is very sensitive to the photoelectric effect of these rays.—Georges **Meslin**: Thermoelectric couples.—A. **Leduc**: A new method for determining the ratio of the two specific heats of a gas. This is a modification of the Laplace method, and has the advantage of requiring no other instrument than a good balance and thermometer. A large globe of not less than three litres capacity is filled with the gas at 0° C., and accurately weighed. It is then placed in a bath at a known temperature, the tap momentarily opened, and the mass of gas remaining in the globe determined by weighing. The theory and limits of accuracy of the method are worked out in the paper.—Henri **Stassano**: The opposed actions of the magnetic field on the electrical conductivity of rarefied gases as a function of the value of the field and the degree of vacuum.—M. **Lelarge**: A cause of explosion of tubes containing a compressed mixture of air and hydrogen. While measuring the pressure and density of some compressed hydrogen, an explosion occurred in which two workmen were killed. The author has investigated the conditions under which such an explosion may take place, and draws some practical conclusions from his experiments with a view to avoid such explosions in future.—J. **Couyat**: A meteorite from Hedjaz, Arabia. A full chemical and mineralogical analysis of the meteorite is given.—Paul **Vuillemin**: Periodic variation in specific characters. Studies of the flowers of *Phlox subulata*.—A. **Petit**: The non-fixation of phosphoric acid by an acid forest soil.—L. **Lindet**: The conditions of combination of calcium and phosphorus in the casein of milk. About one-half of the phosphorus contained in casein precipitated from milk by rennet is in the condition of calcium phosphate, but the other half is in organic combination as a phosphate. Only three-fifths of the calcium is combined with phosphoric acid, the remainder saturating the free acidity of the casein.—Marcel **Mirande**: The existence of cyanogenetic principles in *Centaurea crocodylium* and *Tinantia fugax*.—A. **Desmoulière**: The antigen in the Wassermann reaction. A new method of preparation of the antigen is given possessing greater delicacy than the original Wassermann preparation.—Louis **Boutan**: Observations relating to the vocal manifestations of an anthropoid ape, *Hylobates leucogenys*. The sounds emitted by this ape are classified. They differ from a language, properly so-called, in that they are not produced by education, and hence represent nothing conventional, and are simply spontaneous sounds.

BOOKS RECEIVED.

The Botany of Iceland. Edited by Dr. L. K. Rosenvinge and Dr. E. Warming. Part i., The Marine Algal Vegetation. By Dr. H. Jónsson. Pp. vi+186. (Copenhagen: J. Frimodt; London: J. Wheldon and Co.)

Handwörterbuch der Naturwissenschaften. Edited by E. Korschelt and others. Lief. 19–22. (Jena: G. Fischer). Each 2.50 marks.

The Cochin Tribes and Castes. By L. K. A. Krishna Iyer. Vol. ii. Pp. xxiii+504. (Madras: Higginbotham and Co.; London: Luzac and Co.)

Through Shên-Kan. The Account of the Clark Expedition in North China, 1908–9. By R. S. Clark and A. de C. Sowerby. Edited by Major C. H. Cheepmell. Pp. iii+247. (London: T. Fisher Unwin.) 25*s*. net.

The Origin of Civilisation and the Primitive Condition of Man. By the Right Hon. Lord Avebury. Seventh edition. Pp. xxviii+454. (London: Longmans and Co.) 7*s*. 6*d*. net.

The "Newest" Navigation Altitude and Azimuth Tables. By Lieut. R. de Aquino. Second edition. Pp. xlix+176+New Altitude Tables pp. v*+36*. (London: J. D. Potter.) 10*s*. 6*d*. net.

Lehrbuch der Grundwasser- und Quellenkunde. By K. Keilhack. Pp. xi+545. (Berlin: Gebrüder Borntraeger.) 20 marks.

Matematica Dilettevole e Curiosa. By I. Ghersi. Pp. viii+730. (Milano: U. Hoepli.) 9.50 lire.

Trattato di Chimico-Fisica. By Prof. H. C. Jones. Translated by Dr. M. Giua. Pp. xx+611. (Milano: U. Hoepli.) 12 lire.

Geology of New Zealand. By Prof. P. Marshall. Pp. viii+218+map. (Wellington: J. Mackay.)

The Spiritual Interpretation of Nature. By Prof. J. Y. Simpson. Pp. xv+383. (London: Hodder and Stoughton.) 6*s*. net.

The Feet of the Furtive. By C. G. D. Roberts. Pp. 277. (London: Ward, Lock and Co., Ltd.) 6*s*.

Michigan Bird Life. By Prof. W. B. Barrows. Pp. xiv+822+70 plates. (East Lansing, Mich.: Michigan Agricultural College.)

The Childhood of Animals. By Dr. P. C. Mitchell. Pp. xiv+269. (London: W. Heinemann.) 10*s*. net.

Herpetologia Europæa. By Dr. E. Schreiber. Zweite Auflage. Pp. x+960. (Jena: G. Fischer.) 30 marks.

General Report on the Operations of the Survey of India during the Survey Year 1910–11. Prepared under the direction of Col. S. G. Burrard. Pp. vi+29+12 plates. (Calcutta: Surveyor-General of India.)

Fatty Foods: their Practical Examination. By E. R. Bolton and C. Revis. Pp. x+371. (London: J. and A. Churchill.) 10*s*. 6*d*. net.

Key to Hall's School Algebra. Part i. By L. W. Grenville. Pp. 317. (London: Macmillan and Co., Ltd.) 6*s*.

Die Mutationen in der Erblichkeitslehre. By Prof. H. de Vries. Pp. 42. (Berlin: Gebrüder Borntraeger.) 1.60 marks.

Sleeping Sickness. By Dr. F. M. Sandwith. Pp. v+56. (London: Macmillan and Co., Ltd.) 4*d*.

Questions of the Day in Philosophy and Psychology. By Dr. H. L. Stewart. Pp. x+284. (London: E. Arnold.) 10*s*. 6*d*. net.

Les Aciers au Nickel et leurs Applications à l'Horlogerie. By C. E. Guillaume. Pp. 54. (Paris: Gauthier-Villars.) 2 francs.

Canada Department of Mines. Mines Branch. Report on the Utilization of Peat Fuel for the Production of Power. By B. F. Haanel. Pp. xiii+145. (Ottawa: Government Printing Bureau.)

A Primer of the Internal Combustion Engine. By H. E. Wimperis. Pp. xiii+143. (London: Constable and Co., Ltd.) 2s. 6d. net.

The Nature of Woman. By J. L. Tayler. Pp. 186. (London: A. C. Fifield.) 3s. 6d. net.

A New Geometry. Part i. By S. Barnard and J. M. Child. Pp. xii+224. (London: Macmillan and Co., Ltd.) 1s. 6d.

Experimental Mensuration. By H. S. Redgrove. Pp. xvii+328. (London: W. Heinemann.) 2s. 6d. net.

The Flowing Road. Adventuring on the Great Rivers of South America. By C. Whitney. Pp. 319. (London: W. Heinemann.) 12s. 6d. net.

Aëroplanes in Gusts. Soaring Flight and the Stability of Aëroplanes. By S. L. Walkden. Pp. xv+188+4 plates. (London: E. and F. N. Spon, Ltd.) 7s. 6d. net.

Cambridge County Geographies:—Forfarshire. By E. S. Valentine. Pp. viii+160+2 maps. (Cambridge University Press.) 1s. 6d.

Modern Inorganic Chemistry. By Dr. J. W. Mellor. Pp. xx+871. (London: Longmans and Co.) 7s. 6d.

The Soul of Golf. By P. A. Vaile. Pp. xiii+356. (London: Macmillan and Co., Ltd.) 6s. net.

Electricity and its Practical Applications. By Prof. M. Maclean. Pp. xiv+492. (London: Blackie and Son, Ltd.) 10s. 6d. net.

A Course of Physics, Practical and Theoretical. By Dr. C. H. Draper. Pp. xi+413. (London: Blackie and Son, Ltd.) 4s. 6d. net.

An Introduction to the Geology of New South Wales. By C. A. Süssmilch. Pp. xii+177. (Sydney: W. A. Gullick.) 5s.

Lehrbuch der Optik. By Prof. P. Drude. Dritte erweiterte Auflage. Edited by Prof. E. Gehrcke. Pp. xvi+548. (Leipzig: S. Hirzel.) 12 marks.

Elements and Electrons. By Sir W. Ramsay. Pp. ix+173. (London: Harper and Bros.) 2s. 6d. net.

Rough Stone Monuments and their Builders. By T. E. Peet. Pp. xii+172. (London: Harper and Bros.) 2s. 6d. net.

DIARY OF SOCIETIES.

THURSDAY, NOVEMBER 14.

ROYAL SOCIETY, at 4.30.—The Development of a Parasite of Earthworms: J. W. Cropper.—Further Contribution to the Study of the Inheritance of Hoariness in Stocks (Matthiola): Edith R. Saunders.—The Influence of Temperature on the Absorption of Water by Seeds of *Hordeum vulgare* in Relation to the Temperature Coefficient of Chemical Change: Prof. A. J. Brown and F. P. Worley.—Note on *Merlia normani* and the "Monticuliporas": R. Kirkpatrick.—The Chemical Action of *Bacillus cloacae* (Jordan) on Citric and Malic Acids in the Presence and Absence of Oxygen: J. Thompson.—The Origin and Destiny of Cholesterol in the Animal Organism. X. The Excretion of Cholesterol by Man, when Fed on Various Diets: G. W. Ellis and J. A. Gardner.—The Comparative Anatomy and Affinities of the Araucarineae: Prof. R. Boyd Thomson.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Address by the President (W. Duddell.)—Presentation of Premiums.

CONCRETE INSTITUTE, at 7.30.—Presidential Address: E. P. Wells.

MATHEMATICAL SOCIETY, at 5.30.—Annual General Meeting.—Presidential Address on Recent Advances in the Theory of Surfaces: H. F. Baker.—Some Properties of Cubic Surfaces: A. B. Grieve.—The Determination of the Summability of a Function by means of its Fourier Constants: W. H. Young.—Groups of Linear Substitutions of Finite Order which Possess Quadratic Invariants: W. Burnside.—The Irreducibility of Legendre's Polynomials: J. B. Holt.—The Representation of a Summable Function by means of a Series of Finite Polynomials: E. W. Hobson.—Theory of Functions of Real Vectors: E. Cunningham.

FRIDAY, NOVEMBER 15.

ROYAL GEOGRAPHICAL SOCIETY, at 8.45.—The Norwegian South Polar Expedition: Capt. Roald Amundsen.

MONDAY, NOVEMBER 18.

ARISTOTELIAN SOCIETY, at 8.—The Activity of Willing: Prof. G. Dawes Hicks.

TUESDAY, NOVEMBER 19.

ROYAL STATISTICAL SOCIETY, at 5.—Still-births in Relation to Infantile Mortality: Dr. Dudfield.

ILLUMINATING ENGINEERING SOCIETY, at 8.—Ancient Forms of Lamps: J. W. Johnston.—A New Illumination Photometer: Haydn T. Harrison.—Some Simple Colour Boxes: W. C. Clinton.—Photography in Illuminating Engineering: J. S. Dow and V. H. Mackinney.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Further Discussion*: The Construction of the New Dock at Methil: B. H. Blyth, Jun.—Alterations and Improvements of the Port Talbot Docks and Railway during the Last Decade: W. Cleaver.

WEDNESDAY, NOVEMBER 20.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—The Unprecedented East Anglian Rainfall of August 26, 1912: Dr. H. R. Mill.—A Three-year Period in Rainfall: A. P. Jenkin.

GEOLOGICAL SOCIETY, at 8.—The Hafslo Lake and the Solvorn Valley (Norway): H. W. Monckton.—The Genus Aulophyllum: S. Smith.

ROYAL MICROSCOPICAL SOCIETY, at 8.—British Euchytræids. IV. The Genus Henlea: Rev. Hilderic Friend.—*Saccammina Psammosphoera* (North Sea 2): E. Heron-Allen and Arthur Earland.

ENTOMOLOGICAL SOCIETY, at 8.

ROYAL SOCIETY OF ARTS, at 8.—First Ordinary Meeting.—The Opening Address of the One Hundred and Fifty-ninth Session of the Society will be delivered by Lord Sanderson, G.C.B., K.C.M.G.

THURSDAY, NOVEMBER 21.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: An Investigation of the Spectrum of Ionium: A. S. Russell and R. Rossi.—(1) A Note on the Absorption of β Rays; (2) The Similarity in Nature of X and Primary γ Rays: J. A. Gray.—The Spectra of Fluorescent Röntgen Radiations: J. C. Chapman.—Optical Investigation of Solidified Gases. II. The Crystallographic Properties of Hydrogen and Oxygen: W. Wahl.—An Electric Furnace for Experiments *in vacuo* at Temperatures up to 1500° C.: R. E. Slade.—An Investigation of the Dissociation-Pressures and Melting Points of the System Copper, Cuprous Oxide: R. E. Slade and F. D. Farrow.—Note on the Capacity Coefficient of Spheres: Dr. A. Russell.

INSTITUTION OF MINING AND METALLURGY, at 8.

FRIDAY, NOVEMBER 22.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Vapour-Compression Refrigerating Machines: J. Wemyss Anderson.—A Contribution to the Theory of Refrigerating Machines: Dr. J. H. Grindley.

PHYSICAL SOCIETY, at 5.—(1) The Law of Plastic Flow of a Ductile Material; (2) Kinematograph Illustrations of the Torsion and Breaking of Large Specimens: C. E. Larard.—A Column Testing Machine: Prof. E. G. Coker.

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