THURSDAY, JULY 9, 1914.

HISTORY AND PHILOSOPHY OF MATHEMATICS.

(1) *Le Scienze Esatte Nell' Antica Grecia.* By Prof. G. Loria. Second edition. Pp. xxiv + 970. (Milan: Ulrico Hoepli, 1914.) Price 9.50 lire.

(2) *Ist es wahr dass 2 × 2 = 4 ist?* By Fred Bon. Vol. i. Pp. xxviii + 523. (Leipzig: Emmanuel Reinicke, 1913.)

(1) IN 1889 Prof. Gino Loria's notice was directed to a prize offered for the best history of mathematics. On turning his attention to this subject the author tells us that he became so interested in the study of the ancient Greek mathematicians that he decided to devote his attention to this instead of the more general subject. His previous writings have been published in the transactions of the academies of Turin and Modena, the latter between 1893 and 1902, and it is largely on these that the present volume is based.

The work treats mainly of geometry and arithmetic, but applied mathematics is dealt with in one of the five books, in so far as it relates to astronomy, geodesy, and spherical geometry. Prof. Loria divides the history of Greek geometry into three periods—the pre-Euclidean period of Pythagoras, Socrates, and Plato; the "golden" period of Euclid, Archimedes, Eratosthenes, and Apollonius, and a third period which is described as the "silver" or Græco-Roman age, of which Pappus of Alexandria forms one of the central figures.

In the section dealing with arithmetic and theory of numbers, great interest centres round the work of Diophantus, the discussion of which occupies eighty pages. The list of equations solved by this remarkable mathematician, stated in the notation of modern algebra, alone occupies twelve pages, and Prof. Loria has been throughout very careful in connecting these old problems with their present-day equivalents.

It is a great mistake that the Greek mathematicians in this book are only described by their modern Italian names. Such names as Erone, Tolomeo, Anassagora, Omero, will not convey much idea to foreign readers. The least the author should have done would have been to give the correct names in the index at the end, but this he has not done.

For a treatise of this character the small-sized pages of the Manueli Hoepli are a serious disadvantage. A pocket-book, the letterpress pages of which are a little larger than a quarter-plate negative, but smaller than "post-card" size may be suitable enough as a medium of publication for such subjects as ferro-concrete buildings, diseases of pigs, poultry farming, acetylene, or even calculus for engineers. But for a subject so teeming with points of historical and mathematical facts to be condensed into these tiny pages, closely printed in small type, renders the book very difficult reading indeed. The strain involved in reading the letterpress greatly increases the difficulty of assimilating the subject-matter.

(2) The inquiring reader who wishes to ascertain the truth, or otherwise, of the statement that two and two make four will not find Bon's attempts to enlighten him on this matter cramped by want of space. When he has come to the end of these 520 octavo pages he will only have learnt what the author has to say regarding the nature and meaning of concept, judgment, and truth, and he will have seen that this is only the first volume of Bon's work. He certainly will not yet have arrived at any definite conclusions as to whether two and two really make four or five, for that matter. This volume is divided into three parts, dealing with the nature and meaning of a concept, a decision, and of truth, with the object of examining what these mean, and under what conditions it is possible to assert that a decision is true.

In the chapter on the definition of a concept, the author starts with the statement that concepts are words, and arrives at the following kind of definition.

By *concept* we understand a word which has a meaning for one or more individuals, or, by *concept* we understand a word which is understood by one or more individuals. This attempt to identify a concept with a *word* will certainly not meet with unanimous acceptance, even in spite of the detailed discussions, extending over more than 230 pages, which follow. It might surely be objected that a concept can exist independently of words, and that it is not the word itself, but its meaning, or something which is associated with the word, which constitutes the concept. Of course, the author has to examine what is understood by meaning, by understanding, by words, or by a definition, whether a concept is definable or not, and if so, how far this is possible; at the same time, it is evident from what has been said that the author's views will not meet with universal acceptance.

In the definition of a decision or judgment (Urteil) (p. 261) the author again uses language as the basis of his definition, regarding a decision as a sequence of words which has a meaning independent of the meanings of the separate words and is understood by one or more definite individuals.

Chapter xii. contains some interesting paradoxes, especially those dealing with infinity. One of these may be briefly cited (pp. 241–243). If we suppose that a straight line is bisected and each half again bisected, and so on, and if we imagine that a limit exists when the segments become indivisible, we obtain, according to the author, an impossible result when we apply the method to the repeated bisection of a side and the diagonal of a square. Here, again, the present reviewer does not consider that the author of this book has quite arrived at the right explanation. If a line is made up of indivisible elements, this would seem to mean that it consists of a series of points, and unless the number of such points is an exact power of two the process of successive bisection will stop short long before the infinitesimal elements have been reached.

In the section dealing with "truth" the author classifies the various kinds of truth under different headings, such as that which is accepted as true, that which has been proved to be true by one or more experimental tests, that which has never been shown to be false, that which is in agreement with our laws of thought or with assumptions. He also devotes a whole chapter to the discussion of "half truths."

In expressing a doubt as to how far the author has succeeded in getting "nearer the truth," it must be admitted that the author has every right to attempt to place the remarks of the reviewer in one of his following categories: "The decision is true," "The decision is not true," "The decision is half true," "The decision is only true under certain conditions." But an equal right is possessed by any student of philosophy who will read the book, and it will probably be better if this test is applied to the book itself rather than to the very superficial and impressionistic description of a work of 523 pages which has been possible in the present limited space.

PRECURSORS OF CHRISTIANITY.

The Golden Bough: a Study in Magic and Religion. By Prof. J. G. Frazer. Third edition. Part iv., Adonis, Attis, Osiris: Studies in the History of Oriental Religion. Third edition, revised and enlarged. Vol. i., pp. xvii+317. Vol. ii., pp. x+321. (London: Macmillan and Co., Ltd., 1914.) Price, 2 vols., 20*s.* net.

THE historical applications of Prof. Frazer's researches in early religion may be said to culminate in his study of the distinctive cults of ancient Syria, Phrygia, and Egypt. For through the agency of these three worships, spreading as they did through Greco-Roman Europe two thousand years ago, a continuity was established between the barbarism which was past and the civilisation which was coming. The link thus formed was, not to put too fine a point upon it, the Christian religion. Prof. Frazer regards the founder of Christianity as a historical personage, like Buddha, and both religions, so similar in their ideals, as ethical revolutions, aiming at a higher life than was possible for the majority of mankind.

"Both systems were in their origin essentially ethical reforms, born of the generous ardour, the lofty aspirations, the tender compassion of their noble Founders, two of those beautiful spirits who appear at rare intervals on earth, like beings come from a better world to support and guide our weak and erring nature. Both preached moral virtue as the means of accomplishing what they regarded as the supreme object of life, the eternal salvation of the individual soul, though by a curious antithesis the one sought that salvation in a blissful eternity, the other in a final release from suffering, in annihilation."

The author goes on to describe the process of accommodation—

"but the austere ideals of sanctity which they inculcated were two deeply opposed, not only to the frailties, but to the natural instincts of humanity ever to be carried out in practice by more than a small number of disciples. . . . If such faiths were to be nominally accepted by whole nations or even by the world, it was essential that they should first be modified or transformed so as to accord in some measure with the prejudices, the passions, the superstitions of the vulgar."

This is much in the style of Gibbon, and has a similar, though more sympathetic, spirit. The Protestantism of the early Christians was—

"exchanged for the supple policy, the easy tolerance, the comprehensive charity of shrewd ecclesiastics, who clearly perceived that if Christianity was to conquer the world, it could only do so by relaxing the too rigid principles of its Founder, by widening a little the narrow gate which leads to salvation."

One great lesson of these volumes is what may be called the permanent appeal of the elements of primitive superstition; another is the way in which Christianity has taken up those elements and transmuted them. It is the eternal compromise between the primitive and the modern in man.

"Yet it would be unfair," the author well adds, "to the generality of our kind to ascribe wholly to their intellectual and moral weakness the gradual divergence of Buddhism and Christianity from their primitive patterns. For it should never be forgotten that by their glorification of poverty and celibacy both these religions struck straight at the root, not merely of civil society,

but of human existence. The blow was parried by the wisdom or the folly of the vast majority of mankind, who refused to purchase a chance of saving their souls with the certainty of extinguishing the species."

The substance of "Adonis, Attis, Osiris" is the story of how their faiths provided the machinery for Christianity. The moral of it is the historical appraisement of Occidental religion in modern culture which the student who runs may read. A. E. CRAWLEY.

HABERLANDT'S PLANT ANATOMY.

Physiological Plant Anatomy. By Prof. G. Haberlandt. Translated from the fourth German edition by Montagu Drummond. Pp. xv+777. (London: Macmillan and Co., Ltd., 1914.) Price 25*s.* net.

ANATOMY, whether of animals or of plants, is apt to prove dull reading if treated merely from the descriptive point of view. Such books we know; some have even been translated into English—it is hard to say why, for they are mere repositories of dry facts, and the individual dry bones, one would have thought, could well enough have been dug out of the original treatises whenever they were wanted. It is only when it is related to, or becomes part of, a larger and more philosophical scheme that anatomy becomes attractive to the ordinary scientifically minded reader who is not a specialist in the subject.

The great charm of Prof. Haberlandt's book has always lain rather in the circumstance that the anatomical facts had there been welded into a coherent theme of which the *leit motiv* was Function. It is true that speculation sometimes usurps the place of proof, and that teleology now and then breaks out, cloaked but thinly in the disguise of physiology. But it is a great book, and the fact that it has passed through four German editions, each an improvement on its predecessor, is a testimony to its intrinsic value.

Now that it is accessible to the English reader who happens to be unacquainted with German, its influence will be more widely felt amongst the students of botany in English-speaking countries. It deserves to be well received, for Mr. Drummond has discharged his task with ability, and by deciding on a somewhat free style of translation he has succeeded in producing a very readable volume which contains but little trace of its exotic origin.

In so far as we have tested the translation, we have lighted upon remarkably few errors of any importance; but perhaps it is not altogether superfluous to point out one instance in which a closer adherence to the text would have been of advantage. On p. 550, in discussing the relations existing between the assumed micellar structure and differential imbibition, the micellæ are said to "cohere with different intensities in different tangential planes." By translating the German word *richtungen* (directions) as *planes*, the meaning of the passage is obscured, and a situation already sufficiently complicated is rendered less intelligible.

It may be questioned whether any good purpose has been secured by placing all the notes at the end of the book, instead of grouping them with the chapters to which they severally belong, as they appear in the German edition. But this is, after all, a trifling matter, and at the most detracts but little from the excellent form in which a valuable and indeed classical work has been presented to the English reader. J. B. F.

ELECTROTECHNICS.

(1) *Switchgear and the Control of Electric Light and Power Circuits.* By A. G. Collis. Pp. 85. (London: Constable and Co., Ltd., 1913.) Price 1*s.* net.

(2) *Elementary Theory of Alternate Current Working.* By Capt. G. L. Hall. Pp. vi+195. (London: *The Electrician* Printing and Publishing Co., Ltd., n.d.) Price 3*s.* 6*d.* net.

(3) *Electricity in Mining.* With plans and illustrations. Siemens Brothers Dynamo Works, Ltd. Pp. xiv+201. (London: C. Griffin and Co., Ltd., 1913.) Price 10*s.* 6*d.* net.

(4) *Electric Circuit Theory and Calculations: a Practical Book for Engineers, Students, Contractors, and Wiremen.* By W. Perren Maycock. Pp. xiv+355. (London and New York: Whittaker and Co., 1913.) Price 3*s.* 6*d.* net.

(1) IN the preface to this manual the reader is referred for further information to the author's larger work on the subject. The present book would have been more valuable had it been carefully prepared. Some of the diagrams of the connections are inaccurate, and it is very difficult to make out what they mean.

(2) This work can be well recommended to those who are seeking the elementary theory of the subject. It has been compiled with accuracy and care, and forms a good introduction to the larger works on the subject of alternate current working. The latest developments are dealt with, and the whole treated in a simple manner without the aid of advanced mathematics.

(3) The novelty attaching to this work lies in the fact that it is compiled by a firm of electrical engineers. It is not a mere catalogue or description of electrical apparatus, but goes further, and deals with the technical part of the subject. The illustrations are good, and the book is well produced.

(4) This is one of Mr. Maycock's many works on electrical subjects, and is intended to deal with the requirements of Grade I. and the final examinations in electric wiremen's work of the City and Guilds of London Institute. It is therefore essentially a book for beginners, and as such can be recommended. It contains a number of questions and their solutions.

OUR BOOKSHELF.

Careers for Our Sons. A Practical Handbook to the Professions and Commercial Life. Edited by the Rev. G. H. Williams. Pp. xii+564. Fourth edition. (London: A. and C. Black, 1914.) Price 5*s*. net.

THAT this book has reached a fourth edition since its first appearance ten years ago is an indication of its usefulness to parents and guardians. There are few more baffling tasks than to find a suitable opening for a boy whose school and college training are completed, but who has no clear idea of what he desires to do to secure a livelihood. To those who are face to face with the problem this complete and well-arranged compilation may be recommended confidently. Mr. Williams is an old schoolmaster who has supplemented his own wide experience by much valuable information gathered from a large number of experts.

Manks Antiquities. By P. M. C. Kermode and Prof. W. A. Herdman. Second edition. Pp. 150. (Liverpool: University Press, 1914.) Price 3*s*. net.

THE first edition of this book, which was out of print for some time, was reviewed at length in the issue of NATURE for June 14, 1906 (vol. lxxiv., p. 152). During the ten years since the original appearance of the work, the authors have explored several additional prehistoric sites, and a systematic survey of the antiquities of each parish has been undertaken by a committee of the Isle of Man Natural History and Antiquarian Society. From these and other sources much new material has been worked into the present edition of the book, which will prove of interest and service to the people of the island and their summer visitors.

Royal Society of London. Catalogue of Scientific Papers, 1800–1900. Subject Index. Vol. iii., Physics. Part II., Electricity and Magnetism. Pp. xv+927+vii. (Cambridge: The University Press, 1914.) Price 15*s*. net.

IN the review of the first part of the third volume of the Royal Society's catalogue of scientific papers, which appeared in NATURE on May 22, 1913 (vol. xci., p. 289), the general plan and scope of the work were described. It will be sufficient to say of this part that it completes the subject index on physics, deals with electricity and magnetism under the registration numbers 4900 to 6850, and contains 23,300 entries. This makes in all 56,644 entries for the subject physics for the years 1800–1900 inclusive.

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.*]

Active Nitrogen.

IN view of the apparently inexplicable contradiction between the results of Tiede and Domcke (*Ber.*, 1913, 46, 340 and 4095) and Baker and Strutt (*Ber.*, 1914, 47, 801 and 1049) on this subject, Tiede and Domcke offered to visit London with their apparatus, and it was arranged that each pair of experimenters should repeat their experiments in presence of the other. This was done, and as a result it was agreed that Tiede and Domcke were justified in their statement that the addition of a trace of oxygen to the azide nitrogen increased the intensity of the glow. With the form of discharge vessel and the electrical equipment used by them it was possible to diminish the afterglow considerably, and then to restore the brilliancy of the glow by the addition of an infinitesimal trace of oxygen, liberated by gentle heat from silver oxide. When the amount of oxygen added exceeded this very small quantity, the glow entirely disappeared, as all former experimenters have agreed.

On the other hand, employing the form of discharge vessel used by Baker and Strutt, which has not been described in detail, but is better designed for obtaining the glow, it was not found possible to observe any distinct diminution in the intensity of the glow, even when the vessel was washed out several times with nitrogen prepared by Tiede and Domcke with their own materials, as used in the previous experiment. It is always possible that if the experiment had been more prolonged a different result might have been obtained.

It appears, therefore, that a sample of nitrogen may be made to give the glow more easily if it is mixed with a trace of oxygen. On the other hand, the purest nitrogen with which we have worked in our joint experiments in London is capable of giving a brilliant glow under the experimental conditions used by Baker and Strutt.

It seems possible that the effect of the infinitesimal trace of oxygen is to alter the conditions of discharge so as to make it more suitable for the production of active nitrogen. Prof. Warburg's observations of the effect of traces of oxygen on the kathode fall in nitrogen tends to confirm this idea. Possibly other substances than oxygen may be found eventually to produce the same effect.

H. B. BAKER.
ERICH TIEDE.
R. J. STRUTT.
EMIL DOMCKE.
Imperial College of Science and Technology,
London, July 2.

The Horns of the Okapi.

HITHERTO it has been considered that the horns of the male okapi, with the exception of the bare antler-like terminal caps, are permanently covered with hairy skin, like those of giraffes. The skin and skeleton of an old male okapi recently sent to Messrs. Gerrard, of Camden Town, by Dr. Christy, seem, however, to indicate that, extraordinary as it may appear, true horn-sheaths, like those of antelopes, are developed in at least some individuals. The skull, which, from the condition of the teeth, indicates an animal at least

as old as the oldest of those figured in the respective memoirs of M. Fraipont and Sir Ray Lankester, carries the usual pair of conical bony horn-cores, which appear to have been devoid of terminal antler-like caps. In place of these being covered with hairy skin, the specimen, as mounted by Messrs. Gerrard, shows, however, that they were invested with (so far as I was able to determine) true horny sheaths, resembling candle-extinguishers, and recalling the terminal sheaths surmounting the hair-covered horn-cores of a prongbuck with newly developing horns figured by Dr. Sclater on p. 540 of the Proc. Zool. Soc. for 1880. Messrs. Gerrard were positive that the sheaths came with the skin, and as they appear to correspond in size with the bony cores, I see no reason to doubt the statement, more especially as the sheaths cannot apparently have pertained to any adult antelope.

Were it not for the fact that Dr. Christy is at present somewhere in the Belgian Congo, collecting on behalf of the Museum at Tervueren, I should have deferred making any statement on the subject until I had communicated with him. But as it may be months before I get a reply to a letter just dispatched (even if it ever reaches its destination), I have considered it advisable to put my observations on record, without, however, for the present, making them the basis of any deductions or speculations.

R. LYDEKKER.

Thorium Lead—An Unstable Product.

THE work of Boltwood and Holmes some years ago on the occurrence of lead and uranium in minerals rendered it very improbable that the end product of thorium could be lead. From recent generalisations, however, in respect to radio-elements and the periodic law, it is to be expected that the end products of the radio-active elements should all be isotopic with lead. One method of attacking the problem is the determination of the atomic weight of lead extracted from uranium and thorium minerals. On the assumption that radium G and thorium E are stable, a knowledge of the composition of the mineral from which the lead has been extracted enables one to calculate the expected value for the atomic weight of the lead. Comparison of this value with that found experimentally gives a means of testing whether radium G and thorium E are stable or not.

Using this method, Soddy and Hyman (Trans. Chem. Soc., 1914, vol. cv., p. 1402) obtained a result for lead from a thorite rich in thorium and poor in uranium, which indicates that thorium E is stable. On the other hand, Richards and Lembert made a determination on lead extracted from thorianite, which points to the instability of thorium E (see Fajans, *Heidelberger Sitz. Ber. A.*, 1914, *Abh.* 11). Holmes (NATURE, April 2, 1914) came to a similar conclusion by an examination of the ratio Pb/U_r for a series of analyses of radio-active minerals. If thorium E be stable, this ratio should be constant for minerals of the same geological age, but it should increase with the age of the mineral. Neither criterion was satisfied. In order to examine the question more fully, Holmes and the present writer examined the lead, uranium, and thorium contents of a series of radio-active minerals of Devonian age, from the same locality in Norway. The results of this investigation, shortly to be published, indicate very strongly that thorium E is unstable, and that it cannot therefore be regarded as the end product of thorium.

The present letter indicates how the above results have been applied by the writer to determine the half period value of thorium E, and the method has the advantage that it is quite independent of whether thorium lead (thorium E) is stable or not. A more detailed discussion of the question and its consequences will be published in the near future.

Amongst the minerals analysed by Holmes and the writer were several thorites and orangites, rich in thorium, and well adapted for an examination of the question of the stability of thorium E. These minerals being all of the same age, the total lead present may be regarded as the sum of the following three constituents: (1) Original lead (Pb_1), (2) uranium lead, (3) thorium lead. Further, whether uranium lead and thorium lead are stable or unstable, we can express the above statement as an equation thus:—

$$Pb = Pb_1 + \lambda.Th + \kappa.U.$$

Here Pb, U, and Th represent the content of the mineral in lead, uranium, and thorium respectively; λ is the amount of thorium E in equilibrium with 1 gram of thorium, and κ is the amount of uranium lead present in the mineral per gram of uranium. This last factor κ is constant for minerals of the same age, and varies in sympathy with the age of the mineral—this indicating that radium G is a stable product. The amount of original lead was assumed constant, since the minerals used were similar and from the same locality. Using the results of the analyses of three minerals, three equations are obtained by substitution in that above, and from these equations the values of λ, κ, and Pb_1 can be calculated. This calculation was performed with three different mineral combinations, and consistent results were obtained. The value of λ found was 4×10^{-5} gram. The value of κ found was 0·042, a result known to be correct from other considerations. Now it can readily be shown that the lead-producing power (calculated from the helium generation) of thorium is about 0·4 that of uranium. Whence, if thorium E is stable, the value of λ should be $0{\cdot}4 \times 0{\cdot}042 = 0{\cdot}017$. The low value ($4 \times 10^{-5}$) actually obtained seems to prove beyond question that thorium lead is unstable, and that it has a half period equal to 4×10^{-5} times that of thorium, or $4.10^{-5} \times 1{\cdot}5.10^{10} = 6.10^{5}$ years. It does not seem likely that thorium lead (thorium E) emits α rays, for these should have a range of about 3 cm., and would have been detected. If, on the other hand, it emits β rays, it is to be expected that bismuth would prove to be the end product of thorium. In any case, the systematic examination of radio-active minerals for bismuth seems highly desirable, for if it is the stable end product of thorium, the ratio Bi/Th will be found constant for minerals of the same geological age, and this ratio will vary in sympathy with the age of the mineral. Thus this ratio could be used for the determination of geological time just as that of lead to uranium has hitherto been used by Holmes ("The Age of the Earth," London; 1913) for the same purpose. If the bismuth isotope from thorium is unstable, the method indicated in this letter could be used to find its half period, and thus further information could be gathered as to the direction of the succeeding disintegration, *i.e.*, whether an α ray change brings the end product into Group III.B (Thallium) or a β ray change carries it still further to the Polonium Group (VI.B).

The one doubtful assumption in the present treatment is that in the minerals used for the calculation of λ, the percentage of original lead present is the same. This assumption is not without foundation, and in a forthcoming publication the writer will adduce evidence in support of the assumption in the case of the minerals used.

ROBERT W. LAWSON.

Radium Institute, Vienna.

Radio-activity and Atomic Numbers.

LET Th_T, Ra_T, Ac_T be the periods of half-change of corresponding members of the thorium, radium, and actinium family respectively, M the atomic number, M(Pb) that of the lead-group, and c a constant ($\pm 4{\cdot}5$); then for all substances emitting α rays—

$$Th_T = \sqrt{Ra_T \cdot Ac_T / c^{M-M(Pb)}}$$

For analogous β-radiators $Ra_T \cdot Ac_T/Th^2_T$, though not unity for group B IV. is >1 for B III., and <1 for B V. (the only three groups in which comparable values are known).

The only exception here, as in all similar relations, is thorium-X (or actinium-X). For radiothorium, where a few months as well as two years are given for the period of half-change, the formula gives the first value. Of course, very accurate results cannot be expected from values like 2 min., 3 min., 0·002 sec., etc., but the differences are nowhere greater than what from this lack of precision must be expected.

	Periods of half-change:	Calculated	Experimental
Radiothorium	$\sqrt{365\times10^5\times19{\cdot}5/4{\cdot}5^8}$	d = 65 days	A few months
Thorium emanation...	$\sqrt{3{\cdot}86\times86400\times3{\cdot}9/4{\cdot}5^4}$	s = 56·4 sec.	53 sec.
Thorium A...	$\sqrt{180\times0{\cdot}002/4{\cdot}5^2}$	s = 0·134 sec.	0·14 sec.
Thorium C^a_1	$\sqrt{45\times24\times0{\cdot}0333/4{\cdot}5}$	h = 2·83 hours	2·87 hours
Ionium...	$4{\cdot}5^8\times65^2/19{\cdot}5$	d = 10^5 years	10^5 years
Radium emanation ...	$4{\cdot}5^4\times53^2/3{\cdot}9$	s = 3·42 days	3·86 days
Radium A	$4{\cdot}5^2\times0{\cdot}14^2/0{\cdot}007$	s = 3·31 min.	3 min.
Radium C^a_1...	$4{\cdot}5\times2{\cdot}87^2/0{\cdot}0333$	h = 46·4 days	45 days
Radio-actinium	$4{\cdot}5^8\times65^2/365\times10^5$	d = 19·5 days	19·5 days
Actinium emanation...	$4{\cdot}5^4\times53^2/3{\cdot}84\times86400$	s = 3·5 sec.	3·9 sec.
Actinium A...	$4{\cdot}5^2\times0{\cdot}14^2/180$	s = 0·0022 sec.	0·002 sec.
Actinium C_2	$4{\cdot}5^2\times10^{-22}/10^{-6}$	s = $2{\cdot}10^{-15}$ sec.	?
Actinium C^a_1	$4{\cdot}5\times2{\cdot}87^2/45\times24$	m = 2·03 min.	2 min.

A. VAN DEN BROEK.

Gorsel, Holland, June 26.

Seeing and Photographing Very Faintly Illuminated Objects.

THE question frequently arises, particularly among astronomers, whether it is possible to photograph objects too faintly illuminated to be seen. At the suggestion of Dr. Mees, the writer, assisted by Mr. Huse, has made some observations with measured illuminations giving comparative sensibilities of the human retina and an extra rapid photographic plate.

The source used was a sort of artificial moon consisting of a 10-candle Tungsten lamp in a metal box over the front of which were placed several layers of dense opal glass. The normal light flux from this surface measured equivalent to 8·6 metre candles. This intensity was further reduced by neutral filters transmitting 1/26 of the light. This source was placed at one end of a 20 ft. tube (our plate resolving power apparatus), at the other end of which a 6 inch F/5·3 telescope objective formed an image on the plate tested, or, with an ocular, on the retina.

The results obtained are tabulated below :—

Int. at source	On plate	On retina	Min. exp.	Vision
(1) 8·6 m.c.	0·24 m.c.	0·69 m.c.	16 sec.	Comportable
(2) 0·33	0·0092	0·026	7 min.	Distinct, unadapt.
(3) 0·0127	0·00035	0·00102	3 hr.	Distinct, after 3 min.
(4) 0·00049	0·000014	0·000039	over 50 hr.	Invisible, adapt.

In experiment (3) the plate illumination was just sufficient to produce a distinct image on a Seed 30 plate after an exposure of three hours, while the illumination on the retina as viewed was three times as great, the source being just easily visible after resting the eye about three minutes in total darkness. In other words, an image on the retina just visible after partial adaptation to darkness would just produce an image on a photographic plate after an exposure of *one hour*. The retina fully adapted to darkness is still a thousand times more sensitive than this.

P. G. NUTTING.

Rochester, N.Y., June.

June Meteors.

A PARAGRAPH referring to some brilliant meteors observed at Bristol on June 25 appeared in NATURE of July 2 (p. 464), and I am induced to send a few details of our June results, for they appear to me to exceed in importance and interest any obtained in any other month for a long period. There are a large number of double observations of the same objects, and I have been enabled to compute the real paths of fourteen, particulars of which are given in the subjoined table. They were all observed by Mr. S. A. Wilson and Mrs. Fiammetta Wilson (marked "W."), and some were recorded by Miss A. Grace Cook and some by myself. The very persevering and accurate observations by Mrs. Wilson and Miss Cook have been very successful in this branch of astronomy in the last few years.

Date 1914	G.M.T. [h. m.	Mag.	Height at first, miles	Height at end, miles	Path miles	Velocity per second, miles	Radiant α	Radiant δ	Observers	Meteor appeared over
June 3	10 30	♀	51	48	160	25	281°	−25°	W. and others	The Wash to Durham
15	11 4½	4–1	60	52	26	19	260°	−22°	W. and W. F. D.	Alton to W. of Reading
,,	11 8½	2	87	62	68	35	279°	−13°	W. and W. F. D.	Wilts to Ross
,,	11 32	6–4	69	53	27	41	315°	+21°	W. and W. F. D.	Tunbridge Wells to Dorking
16	11 0	2–1	69	43	29	29	270°	+50°	W. and F. Denning	Selsey Bill (nearly vertical)
21	11 22	3–4	72	48	37	37	293°	+10°	W. and A. G. C.	Sea 34m. E. of Broadstairs
25	10 51½	>1	48	44	14	20	260°	−24°	W. and W. F. D.	12m. W. of Bristol to Usk [Harwich
,,	11 27½	♀	51	25	45	30	342°	+39°	W. and W. F. D.	12m. N.W. Chelmsford to 6m. N.W.
,,	11 46	5–4	68	48	39	25	258°	+2°	W. and W. F. D.	15m. W. Aldershot to Henley
,,	11 52½	1–♃	59	23	46	18	354°	+77°	W. and W. F. D.	10m. S.W. Luton to 8m. S.E. Reading
,,	11 57½	♃	67	67	52	52	350°	−8°	W. and W. F. D.	4m. N.W. Salisbury to Axbridge
26	11 11½	4–2	78	67	11	25	260°	+70°	W. and A. G. C.	S. of Bedford (nearly vertical)
,,	11 17¾	4–2	75	56	22	44	320°	+61°	W. and A. G. C.	Halstead to Bishops Stortford [Hants
29	11 25	1	64	53	19	26	320°	+19°	W. and W. F. D.	Eng. Chan. 32m. S. of Christchurch,

Now that the most attractive and prolific season for meteoric work is at hand I trust that some readers of NATURE may be inclined to watch the sky and record the apparent paths of such meteors as may appear. They are usually unduly plentiful between the middle of July and middle of August, and the great Perseid shower can be favourably traced during nearly the whole of the period named.

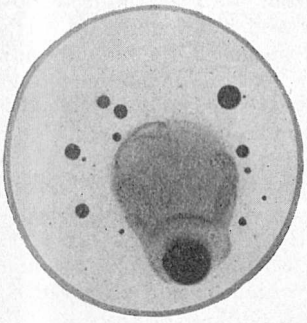
Any observations may be forwarded to the Rev. M. Davidson, director of the Meteoric Section of the British Astronomical Association, or to myself.

W. F. DENNING.

44 Egerton Road, Bristol, July 6 .

Inorganic "Feeding."

AT the January meeting of the Physical Society, and also at the recent conversazione of the Royal Society, I showed an experiment in which one globule of liquid (dimethyl aniline), floating on the surface of water, captures and absorbs other floating globules (orthotoluidine), the movements resembling those of an amœba. I have now succeeded in photographing the process, and in the accompanying print the larger globule is seen in the act of engulfing the smaller and darker-coloured one. To secure contrast, the orthotoluidine was coloured with indigo.



An interesting extension of this experiment is provided by placing a small drop of quinoline on the surface after the absorption of the orthotoluidine is nearly complete. This drop approaches the large globule and makes contact, when it is violently repelled; it again approaches, and is then repelled with less force; and this alternate attraction and repulsion continues until the quinoline drop appears to be nibbling at the edge of the large globule, into which it is finally absorbed. The interesting feature of this process is that at each contact a mutual interchange of liquid occurs; and only when the quinoline has become mixed with a considerable quantity of the liquid composing the larger globule does absorption take place.

CHAS. R. DARLING.
City and Guilds Technical College,
Finsbury, E.C.

EXPERIMENTAL DEMONSTRATION OF AN AMPERE MOLECULAR CURRENT IN A NEARLY PERFECT CONDUCTOR.

IT has long been known that the electrical resistance of metals falls with a reduction of temperature in an approximately straight line law, indicating that, in the neighbourhood of absolute zero, there would be no resistance whatever. Prof. H. Kamerlingh Onnes, of Leyden, has carried experiments on this subject down to extremely low temperatures, and has found that it is at a point a few degrees above absolute zero that the resistance of certain pure metals practically vanishes. His later experiments illustrate the properties of these almost resistanceless bodies, or, as he terms them, "super-conductors," in a very striking way. Taking a closed coil of lead wire, he cooled it down by immersion in liquid helium to a temperature at which its resistance is of the order of 2×10^{-10} that at normal temperatures. He then induced a current in the coil, which, instead of ceasing with the E.M.F., was shown to persist with scarcely sensible diminution for as long a period as the coil could be kept cold. As there was practically no resistance, there was practically no dissipation of energy, and the system behaved like the imagined molecular currents of Ampère, and realised the conception of Maxwell as to a conductor without resistance.

The little coil in question was made of 1,000 turns of lead wire 1/70 mm. diameter, wound on a brass bobbin, and with its ends fused together. Its resistance at a normal temperature was 734 ohms, and it was calculated that the induced current would then only persist for 1/70,000th of a second after removal of the E.M.F. When cooled by liquid helium to 1·8° K. (abs.) the "relaxation time," according to previous determination of the resistance, should be a matter of days. The limiting value to which the current might be raised before the ordinary resistance suddenly makes its appearance had also been calculated, and found to be 0·8 amperes at 1·8° K. The coil was contained in a suitable vessel introduced between the poles of a large electromagnet, which was excited before the liquid helium was poured in. After the coil had been cooled down, the current was cut off from the magnet and a current thus induced. The unexcited magnet was then removed, and the persistence of a current of about 0·6 ampere in the lead coil was demonstrated by a magnetometer arrangement. During an hour no decrease in the magnetic moment produced could be observed, although the temperature had risen to 4·26° K. (that of helium boiling at atmospheric pressure). When the coil was lifted out of the helium the current ceased immediately as the temperature rose above 6° K., which is the "vanishing point" of the resistance of lead.

The experiment was repeated with the windings of the coil parallel to the field, to prove that the effect was not due to some magnetic property of the material of the wire or bobbin, which might only appear at these temperatures; and only a slight effect, such as might be accounted for by asymmetry of the coil, was observed. Further experiments were tried to measure the actual rate of falling off of the current due to the residual micro-resistance, and a falling off of less than 1 per cent. per hour (somewhat less than had been calculated) was all that could be observed. Other experiments finally disposed of all idea of direct magnetic action, and the actual presence of a continuing current was proved independently by attaching galvanometer leads to the points on the coil, and suddenly cutting the wire between them under the helium, when a swing of the galvanometer needle was observed, while the magnetometer immediately went to zero.

MEMORIAL STATUE OF CAPT. COOK.

ON Tuesday, July 7, Prince Arthur of Connaught unveiled a statue of Captain Cook, which stands on the Mall side of the Admiralty Arch, at the end of the Processional Road. The proposal to erect the statue was made in 1908 by Sir J. H. Carruthers, who pointed out that there was no memorial of Captain Cook in London. The matter was taken up by the British Empire League, and a general committee, under the presidency of the Rt. Hon. Herbert Samuel, M.P., was formed to promote the erection of a statue. The necessary funds were raised, and in 1911 Sir T. Brock, R.A., was commissioned to execute the memorial. One hundred and thirty-five years

have elapsed since Cook met his death at the hands of savages in the Sandwich Islands, and it is remarkable that no monument to his memory should have been erected in the capital of the Empire. But if the statue is late it is undoubtedly adequate. The British Empire League deserves the gratitude of all citizens of the empire for its public spirit in raising so worthy a monument to one who extended the imperial bounds.

But James Cook (1728–1779) was more than this. He was a geographer of no mean standing, and his name will go down to posterity as one of the earliest of British discoverers. His three

Photo.] [*A. Burchell, Fulham.*
Statue of Capt. Cook.

voyages, all of them scientific, are well known by now. The first (1768–1770) was undertaken at the instance of the Admiralty, which was moved thereto by the Royal Society, for the purpose of prosecuting geographical researches in the Pacific Ocean. Several well-known men of science accompanied Cook on his voyage, on which, among other things, he struck the coasts of New Zealand and Australia. Round the former he sailed with complete success, examining it in detail; his name is associated with the channel which separates North from South Island (Cook's Strait). Of both New Zealand and Australia he took possession for Great Britain. The second voyage (1772–1775) had for its object the supposed southern continent in the Pacific, and Cook was able to prove finally that no such continent existed. It is worthy of note that on this second journey he reached latitude 71°49′ S. The third expedition was fitted out in 1776, and was principally to settle the question of the North West passage. It was on this voyage, in 1779, that Cook was killed.

Besides his contributions to geography, Cook was also an astronomer and mathematician. His skill as a geographical surveyor he had already shown as early as 1760, when he sounded and surveyed the St. Lawrence river and published a chart of the channel from Quebec to the sea. This activity he continued when, in 1763, he was appointed "Marine Surveyor of the Coast of Newfoundland and Labrador." It was shortly after this appointment that the Royal Society elected him one of its Fellows, on his giving an account of an eclipse of the sun which he had observed on the south coast of Newfoundland.

THE WILDS OF NEW ZEALAND.[1]

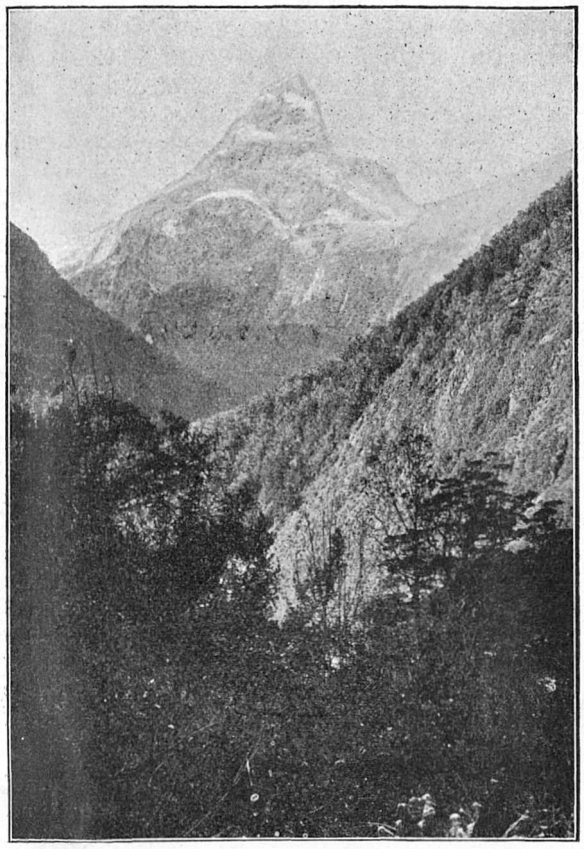
DR. J. M. BELL was for six years the director of the Geological Survey of New Zealand, and during his service there his duties and inclinations carried him into several of the most remote and least settled areas. A series of valuable memoirs on New Zealand geology has already testified to the enthusiasm and energy with which he threw himself into his work. In this volume he records his general reminiscences of his travels, and describes his numerous adventures by the flooded rivers, on the mountains, and in the bush, and narrates various incidents in the early history of the dominion. He was greatly impressed by the rich variety in both the topography and geology of New Zealand, and was delighted with its superb scenery, which is illustrated by a well-selected collection of excellent photographs by the Government Tourist Department, and by a series of artistically coloured sketches by his companion, Mr. C. H. Eastlake.

One of the first chapters describes the north-western province of the North Island, where Dr. Bell went to inspect the diggings for Kauri gum, which by 1912 had yielded produce to the value of more than 16,000,000*l*. In connection with his visit to the Thames goldfield, he summarises its mining history, and in connection with the volcanic fields of the North Island, describes his winter ascent of the volcano Ngauruhoe, a climb rendered difficult as the snow around the base was loose and soft, while that on the final slope was dangerously hard and steep. He also describes again the famous eruption of Tarawera, but the Black Geyser, Waimangu, it may be remarked, ceased to discharge daily six months earlier than the time mentioned by Dr. Bell. The most adventurous journey described in the volume was an attempt with Prof. Marshall, of Dunedin, to reach Mt. Arthur in Karamea, the north-

[1] "The Wilds of Maoriland." By Dr. J. M. Bell. Pp. xiii+253+plate London: Macmillan and Co., Ltd., 1914.) Price 15*s*.

western part of the South Island, when, owing to the roughness of the way and a wrong route, four days' provisions had to serve for seven, and the party might not have survived except for some chance birds that were killed by stones.

The last chapters describe Dr. Bell's journeys in the Southern Alps, and give a brief summary of the geography and climate of New Zealand. Most of the author's results have been stated in his geological papers, and as the present work is essentially popular he has excluded technical matter; but he writes of different areas with the intimate knowledge gained in the course of his surveys. The book gives an interesting account of the author's journeys, and is a useful record of the present conditions of some of the less-



Mount Balloon, near the track to Milford Sound. From "The Wilds of Maoriland."

known parts of New Zealand; it conveys a good impression of the magnificence and variety of New Zealand scenery, but indicates that the conditions of travel there are exceptionally rough and the accommodation often poor.

RECENT PROGRESS OF THE METRIC SYSTEM.[1]

WE have received a copy of a report on the progress of the metric system which was presented by Dr. Guillaume at the meeting of the fifth general conference on weights and measures held in Paris in October last. A previous report by Dr. Guillaume on the same subject was reviewed in these columns in 1908 (April 30). In the first part of the present work the author deals with the question of standards of measure and weight. As regards the use of vitreous quartz or silica for the construction of standards of length he points out that recent investigations tend to show that this material is unsuitable for the purpose, owing to inconstancy of length. A historical account is then given of the attempts made at the international bureau to find an appropriate material for the construction of standards of length for use in the laboratory, where the question of cost prohibits the employment of iridio-platinum. These efforts led to the important series of investigations with respect to the metrological properties of the alloys of nickel and steel, and to the discovery by Dr. Guillaume of the alloy of minimum expansion, now well known as "invar." The feeble expansion of invar would render this alloy an ideal material for standards of precision were it not for its tendency to instability. In spite of this drawback, however, its use for secondary standards deserves careful consideration in cases where an accuracy of one part in a million is sufficient.

Researches have also been made with the view of finding suitable alloys to replace iridio-platinum for the construction of secondary standards of weight. Various non-magnetic alloys of nickel were investigated. Of these constantan was found to be unsuitable, owing to its lack of durability, but "baros," formed by the addition of small quantities of chromium and manganese to commercial nickel, has proved to be more satisfactory. Tungsten, in virtue of its hardness, high density and durability, promises to be a very suitable material, especially as it seems likely that this metal will soon be obtainable at a relatively low price. Dr. Guillaume also discusses the results of recent researches with reference to the employment of wave-lengths of light in metrology, and points out that the gases krypton and neon both afford special advantages as regards interference measurements.

A section is devoted to legislation with respect to the metric system in various countries since the fourth general conference. During the past six years the system has been made obligatory in several countries, notably Denmark, Siam, the Belgian Congo, and certain of the republics of Central America. Dr. Guillaume considers that the difficulties standing in the way of the adoption of the system in Great Britain and the United States have been greatly exaggerated by its opponents. He urges that in the engineering trade, for example, the proposed innovation would not, as is often alleged, necessarily put out of use all machines the dimensions of which could not be expressed in convenient figures in terms of metric units; the first reform would be simply to give the metric equivalents of the quantities hitherto expressed in Imperial units; later on, when the machines were being replaced by new ones in the usual course, any slight modifications required might be introduced.

[1] "Les récents Progrès du Système métrique." By Ch. Ed. Guillaume. Pp. 118. (Paris: Gauthier-Villars, 1913.) Price 5 francs.

NOTES.

THE death of Mr. Joseph Chamberlain on July 2, at seventy-eight years of age, deprives the nation of a statesman who was not only a great political leader in the affairs of his country and Empire, but also gave notable assistance to the advancement of science and education. A few days ago the work done by him and his son, Mr. Austen Chamberlain, was commemorated by the unveiling of portraits of them in bronze relief in the branch hospital at the Royal Victoria and Albert Docks connected with the London School of Tropical Medicine; and the University of Birmingham, of which he was Chancellor, is a sufficient monument to what he did to promote national efficiency through education and research. Mr. Chamberlain began his public work in the city of Birmingham as an educational reformer and took an active part in the work of the first School Board there, while the University was practically founded by him. Speaking at a meeting of the council last week, the Vice-Chancellor, Mr. Gilbert Barling, said that Mr. Chamberlain guided the formation of the University and influenced its constitution in the most liberal and broad-minded manner. He obtained most of the funds for its building and equipment, and took the warmest interest in its welfare during the whole of his life after its foundation. The council of the University has expressed its high appreciation of Mr. Chamberlain's services in this direction by passing the following resolution:—"The council hears with profound sorrow of the death of Mr. Joseph Chamberlain, first Chancellor of the University, to whom the University owed its existence. His liberal and broad-minded views permeated its constitution, his judgment guided its policy from the commencement, and by his personal effort he secured munificent contributions to the funds for the buildings and equipment. The Chancellor's death will be felt by all members of the council and Senate, and indeed by the whole of the University, as a great personal loss." Few statesmen show such zeal for education and science as Mr. Chamberlain did; and we join with representatives of other national interests in mourning the loss of one who understood so well the business of government of a modern State. Mr. Chamberlain was admitted a fellow of the Royal Society in 1882, under the rule which permits the election of persons who "either have rendered conspicuous service to the cause of science, or are such that their election would be of signal benefit to the society."

BY the death of Sir Benjamin Stone, on July 2, at seventy-six years of age, there has passed from us one of the most enthusiastic and energetic of amateur photographers. Although photography was his recreation, he made a business of it in the sense of always working towards a definite end, namely, the getting of pictorial records of the details of the life of to-day. He did not initiate what is now well understood as "record work," but in 1897, when he was sixty years of age, he established the National Photographic Record Association, which did excellent work for twelve years, when it was disbanded so that the work might be carried on more effectively from local centres. During the whole life of the association Sir Benjamin Stone was its head, and we believe contributed personally a greater number than any other member of the nearly five thousand prints which are now deposited in the British Museum. These photographs represent interesting buildings of all kinds, remains of ancient buildings, manuscripts, portraits, ceremonies, customs, such as coronations, the distribution of Maundy money, fairs, and indeed anything that is likely to be of interest, especially when it has ceased to be.

CAPT. J. F. PARRY, R.N., assistant hydrographer, has been appointed to succeed Rear-Admiral Herbert E. P. Cust, C.B., as hydrographer of the Navy from August 16 next.

THE president and council of the Royal Society have awarded the Mackinnon studentship on the biological side to Mr. G. Matthai, of Emmanuel College, Cambridge, for a research on the comparative anatomy of the Madreporaria. The studentship on the physical side has not yet been awarded, and the date for receiving applications has been extended to September 21.

PROF. J. H. APPLETON has retired from the chair of chemistry at Brown University, Rhode Island. He graduated at that University in 1863, and has ever since been a member of its faculty, holding successively the status of assistant instructor, instructor, and professor. Dr. J. E. Bucher, at present assistant professor, is to succeed him in the headship of the department of chemistry.

THE death is reported of Dr. F. W. True, assistant secretary of the Smithsonian Institution, Washington. Born in 1858, Dr. True graduated at New York University in 1878, and in the same year entered the service of the U.S. Government, of the exhibits of which he was custodian at the Berlin Fisheries Exhibition of 1880. From 1883 to 1911 he held curatorships at the National Museum, of which he had previously been librarian. His publications included "A Review of the Family Delphinidæ," "The Whalebone Whale of the Western North Atlantic," and "An Account of the Beaked Whales of the Family Xiphiidæ."

THE Board of Agriculture and Fisheries is informed that on May 26 a porpoise was caught in a kettle net at Dungeness and transferred to Brighton Aquarium, where she arrived in good condition. She was noticed to be in an advanced stage of pregnancy when placed in a tank, and on the afternoon of May 31 gave birth to a young male, which was stillborn. The young was perfectly formed, and measured 2 ft. 2 in. in length, and weighed approximately 7 lb. Unfortunately the mother died on June 10.

IN the course of excavations to reach the base of the Red Crag at Thorington Hall, Wherstead, near Ipswich, Mr. Reid Moir has found the skeleton of a young female, about seventeen years of age, at a depth of 6 ft. from the surface of the ground. The Crag at this spot is capped by a hard, compact, loamy material, in all probability decalcified Boulder Clay, and the bones had been buried in a grave which was plainly visible in the loam. The body, of which nearly

every bone has been recovered, had evidently been buried upon the back, and in the contracted position, the head being turned over the left shoulder and facing due west. On the right-hand side of the skeleton the fragments of an urn were found, which has now been rebuilt, and found to be an elaborately ornamented drinking vessel of the late Neolithic or early Bronze periods. No implements or ornaments of any sort were found with the remains. Both the human bones and the pottery are at present in the care of Prof. Keith at the Royal College of Surgeons, Lincoln's Inn Fields, W.C.

THE Royal Academy of Belgium has issued its programme of prizes to be awarded during 1915. Among the subjects in mathematical and physical science for theses on which prizes from 35*l.* to 40*l.* are offered may be mentioned: the absorption of light in interstellar space; the viscosity of liquids and gases and the properties of fluids near the critical temperature; the organo-metallic compounds of one or more metals of the chromium group; infinitesimal geometry of curved surfaces; and conic systems in space. In the natural sciences, prizes of the same value are offered for researches in the following subjects: the significance of various inflections of the electrocardiogram; the spermatogenesis of burrowing hymenoptera; the subalpine flora of Belgium; a petrographical and geological description of some metamorphic region of the Ardennes; and descriptions of certain groups of Belgian minerals. The memoirs should be written in French, Flemish, or Latin, and be sent, post paid, to M. le Secrétaire Perpétuel, au Palais des Académies, à Bruxelles, before August 1, 1915. The bulletin from which the above particulars are taken also gives information concerning the various permanent prizes to be awarded during the years up to 1918.

THE list of Civil List pensions granted during the year ended March 31 last includes the following grants for scientific services:—Mr. A. J. M. Bell, in recognition of his valuable contribution to geology and palæontology, 60*l.*; Mrs. Traquair, in consideration of the services to science of her husband, the late Dr. R. H. Traquair, F.R.S., and of her own artistic work, 50*l.*; Mrs. Gray, in recognition of the valuable contributions to the science of anthropology made by her husband, the late Mr. John Gray, 50*l.*; Mrs. Wallace, in consideration of the eminent services to science of her husband, the late Dr. Alfred Russel Wallace, O.M., F.R.S., 120*l.*; Mrs. Alcock, in recognition of the valuable contributions to the study of physiology made by her husband, the late Prof. N. H. Alcock, 50*l.*; Mrs. Ward, in recognition of the eminent services of her husband, the late Prof. Marshall Ward, F.R.S., to botanical science 40*l.*; Dr. Oliver Heaviside, F.R.S., in recognition of the importance of his researches in the theory of high-speed telegraphy and long-distance telephony, in addition to his existing pension, 100*l.*; Miss Hearder, in consideration of the contributions to electrical science and telegraphy of her late father, Dr. J. N. Hearder, 70*l.*; Miss Willoughby, in consideration of the services of her late father, Dr. E. F. Willoughby, in connection with questions of public health, 30*l.*

IT is curious that whereas transatlantic telegraphy by submarine cables was accomplished many years before transatlantic wireless telegraphy, the reverse order of things appears more likely in the case of telephony. The great difficulty in long-distance cable telephony is the attenuation and distortion of the current waves in the cable by the effect of its capacity, and in an Atlantic cable it would—at any rate, with our present knowledge—be too expensive to compensate for by "loading" with artificial inductance. In wireless telephony, on the other hand, there is no such distortion depending on the distance. The difficulties are mainly concerned with finding a source of waves with a sufficiently high group frequency in the case of discontinuous waves, or of sufficient steadiness in the case of continuous waves, and constructing a microphone able to deal with the heavy currents necessary at the transmitting end. Successful experiments overcoming these difficulties to a greater or less extent, and in various ways, have been made by several investigators over moderate distances, and it would appear that it is now only a question of time to produce perfected apparatus of greater power, so that a longer range may be covered. Now that the large wireless station near Carnarvon is complete, Mr. Marconi hopes to succeed in telephoning to New York, and, according to a statement made by Mr. Godfrey Isaacs, chairman of the Marconi Company, before the Dominions Royal Commission last week, hopes to do so by the end of this year.

"THE Plumage Bill: What it Means," is the title of a timely brochure by Mr. James Buckland—who may well be called the birds great protector—written with the object of influencing public opinion and stimulating the supporters of the Bill to further exertions in restoring those of its clauses which have been rendered almost nugatory by changes in Committee. In it we find a restatement of the evidence of creditable authorities and eye-witnesses—among them of A. H. Meyer, "himself a one-time plume hunter" and "thoroughly conversant with the methods employed in gathering" them—of the "horrors of the plume-trade," in Florida, Oregon, Australia, Lysan Island, New Guinea, India, and elsewhere, in which egret, grebe, pelican, albatross, kingfisher, and bird of paradise are immolated in millions to gratify the vanity of those women who *will* be feather-decorated whatever be the cruel methods by which their ornaments are obtained. Mr. Buckland emphasises the economic aspect of the question, and the enormous value of birds to the agriculturist in America, Jamaica, Russia, South Africa, and Australia, in which insect pests and rodents—all forming food of birds—are destructive almost beyond computation. Mr. Souef has ascertained by investigation that in a field attacked by a horde of grasshoppers in Australia, a flock of ibises, spoonbills, and cranes which hurried to the spot, were responsible for the destruction daily of 482,000,000 of the marauders. The devastation wrought by them would be infinitely greater if these birds should become exterminated. We commend this pamphlet to all interested in the wanton destruction of birds; and we trust that when the Bill comes up again before the House the "amendments" will be rejected and that

the Bill in its original form may reach the statute-book before the close of this session.

IN *Man* for June Prof. J. Macmillan Brown announces the discovery of a new form of Pacific Ocean script in the little island of Oleai or Uleiai, one of the most westerly of the Caroline group. The chief, Egilimar, furnished a list of fifty-one characters, each of which represents a syllable. It has no connection with any other well-known alphabets, the only other script known in the groups or islands of the Pacific being that of the Easter Island tablets, which are ideographic. The Oleai syllabic script is a stage further than these in the development of an alphabet. The script is at present known only to five men on the islet: but it is probably a relic of a wide usage in the archipelago. A similar commercial script is that used in the island of Yap. This Oleai script is manifestly the product of long ages for the use of a highly organised community; in other words, it must have belonged to the ruling class of an empire of some extent that needed constant record of the facts of intercourse and organisation.

THE Commonwealth of Australia, in connection with the approaching visit of the British Association, has issued a "Federal Handbook," describing the continent in its scientific and historical aspects. This book contains in a compressed, but readable, form more information than is elsewhere accessible. Among the more important articles may be noted that on history by Prof. Ernest Scott, on physical and general geography by Mr. Griffith Taylor, and a very useful account of the culture and beliefs of the aborigines by Prof. Baldwin Spencer. The book is at present issued only in a limited edition, and it may be hoped that it will be re-issued to meet the wants of a wider public. The value of a new edition would be increased by a more adequate supply of maps, that of Australasia in particular being on such a small scale, with the names printed in such small type, as to be of little use for practical purposes.

A COLLECTION of fishes from the Rupununi River, British Guiana, is catalogued by Mr. H. W. Fowler in the April issue of the Proceedings of the Philadelphia Academy. A number of species are described as new, a few of which are referred to new genera or subgenera.

THE second part of the first volume of the new series of the Transactions of the Vale of Derwent Naturalists' Field Club contains one article by the president, Mr. R. S. Bagnall, on the woodlice of Northumberland and Durham, and a second on the centipedes and other myriapods of the Derwent Valley.

SPECIES-BUILDING by hybridisation and mutation is the title of an article contributed by Prof. J. H. Gerould to the June number of the *American Naturalist*. No evidence, it is urged, that species breed absolutely true on a large scale is at present forthcoming, and the assertion that hybrids between well-defined species are invariably infertile *inter se* is far from representing the true facts of the case.

MIMICRY and protective resemblance was the subject chosen by Mr. Rothschild for his presidential address at the anniversary meeting of the Hertfordshire Natural History Society, held at Watford on February 26. As reported in vol. xv., part 3, of the society's Transactions, the president considers natural selection to be the only adequate explanation of the phenomenon. "If a variable species happens to occur together with one or more species which are protected in some way, those individuals of the variable species more or less resembling the protected species have a greater chance of surviving and propagating than the individuals which are not similar to some protected form of animal. The result will be that in the course of generations the offspring will become more and more similar to the models, and the dissimilar examples will gradually be weeded out."

STUDENTS of invertebrate histology will find much to interest them in Miss Sophie Krasińska's memoir, "Beiträge zur Histologie der Medusen," in a recent number of the *Zeitschrift für wissenschaftliche Zoologie* (Bd. 109, Heft 2). Zoologists are accustomed to look upon the histological structure of the jelly-fish as of a very simple character, and, although the discovery is not a new one, it is surprising to find them provided with striated muscle fibres which seem to resemble so closely those of arthropods and vertebrates. The memoir is beautifully illustrated, and shows how much we may still hope to add to our knowledge of the microscopic structure of invertebrate animals by the application of modern methods of investigation.

A NEW series of blue books dealing with Fishery Investigations is now being issued by the Board of Agriculture and Fisheries. Series I. relates to salmon and freshwater fisheries, and vol. i. is now before us. It contains two reports by Dr. A. T. Masterman, of which the first is on investigations upon the salmon with special reference to age determination by the study of scales. The material examined consisted of records of salmon captured in the Wye in the nettings made by the Wye Fisheries Association, including special experimental nettings made during the close season. The most important data deal with the year 1911, commencing in the month of April. The scales of a large number of fish were secured and were specially studied from the point of view of age determination. Dr. Masterman concludes that the majority of Wye smolts remain for two years in the river, but a small proportion remain three years. The scale may be used as a fairly accurate gauge of the age of individual fish up to and including the grilse stage, but is not available for estimation of the period of time spent in the river after the return of the fish. The author regards age estimates of spawned fish from the scales as being of very doubtful value. Dr. Masterman's second report deals with observations on the smelt (*Osmerus esperlanus*). The scales of the smelt are specially suitable for age determination on account of the clear and definite arrangement of the ridges upon them, and the study of these scales is of considerable value in connection with the general question

of the trustworthiness of the method of age-determination by means of scales.

VOL. cxxiii. of the *Sitzungsberichte* of the Vienna Academy of Sciences contains a paper presented on March 26 by Dr. J. v. Hann on the daily range of meteorological elements at the Panama Canal, based on hourly or two-hourly observations made at several stations. The harmonic analysis of the data (pressure, temperature, and humidity) is preceded by tables of monthly and yearly means. The latter show that the highest mean temperature and lowest relative humidity occur in March and April, and the lowest temperature in November. From May to October the humidity is uniformly high, and especially so from January to April, while Colon (on the Atlantic coast) is much damper. Rainfall increases from the Pacific to the Atlantic shore, January to March being very dry. The wettest months on the Pacific slope are May, October, and November; on the Atlantic coast July and October are wettest. Without entering into detail here respecting the results of the laborious calculations entailed in computing the harmonic constituents, we may note that both the whole-day and half-day periods show that an increase of 10° C. in temperature corresponds to a decrease of about 36 per cent. in the relative humidity. Dr. v. Hann remarks that this relation between the two elements is exceedingly regular.

MESSRS. ISENTHAL AND CO. have produced an improved type of electrolytic rectifier. The older forms of the aluminium rectifier or "valve" for converting alternating into continuous current were never very popular; trouble was experienced due to heating of the electrolyte, and the arrangement of the four cells, usually of glass, necessary for rectifying both half-waves of the alternating current, was not always a convenient one. In the new design the electrodes, which are in the form of grids protected from action of the electrolyte at the surface level of the liquid, are placed in a solid seamless steel tank, instead of in four separate glass vessels. The trouble due to temperature rise appears to have been overcome, and the whole apparatus is in a compact and workmanlike form.

THE Board of Trade has now issued a report on the new sight tests used in the Mercantile Marine. This report covers the period of April 1 to December 31, 1913. An improved wool test in which the candidate has to match five colours, and a lantern test, were used. The cases of colour-blindness are divided into those definitely rejected by the local examiners and those referred for a special examination, the local examiner being doubtful. Of the 286 definitely rejected in the local examination 148 failed in both the lantern and the wool test, and 138 failed in the lantern test only; there was no failure with the wool test which passed the lantern test. Of the 286, 93 appealed, 26 being successful. Of 125 referred cases, 20 were referred on both the lantern and wools, 101 on the lantern only, three on the wools only, and one on form vision as well. Of this number there were thirty failures; three of these were referred on both the lantern and wool test, twenty-six on the lantern only, and one on form vision as well. Those referred on the wool test alone were passed.

IN the April number of *Le Radium*, which has just reached us, Dr. C. Ramsauer, of the Radiographic Institute of the University of Heidelberg, describes a simple method of determining the amounts of radium, thorium, and actinium present in materials, even when the amounts are very small. The method consists in heating the materials to 1150° C. for four minutes, so as to drive out the radio-active emanations accumulated in the material, condensing it on a cold surface, and then studying the decay of activity of the material condensed. By a comparison of the decay curve with the decay curves obtained in the same way from the three radio-active substances separately, he finds he can deduce the quantities of the three present in the material tested with an accuracy of about 20 per cent. A test of the Kreuznach waters by this method led to a result in agreement with that previously obtained by the more accurate method of Becker which, however, determines the radium content only.

THE June number of the Proceedings of the Physical Society of London contains several papers of exceptional interest. In the first instance, there is the Guthrie lecture by Prof. R. W. Wood, on his recent work on resonance spectra, which he hopes will do something towards unlocking the secret of molecular radiation. This lecture, which is the first given, is very suitably introduced by a historical note from Prof. G. C. Foster relating to Prof. Guthrie, to whom the Physical Society owes its foundation. A second paper, by Dr. J. G. Gray, describes a number of new gyrostatic devices for manœuvring and stabilising a variety of moving bodies from torpedoes to airships. This paper is well illustrated. Mr. W. R. Bower shows that the problem of the rainbow may be treated by geometrical methods with great advantage, and Mr. S. Butterworth describes a zero method of testing vibration galvanometers. In two papers on radio-active problems, Messrs. T. Barratt and A. B. Wood furnish grounds for the belief that thorium-C consists of two substances, one giving the α and the other the β radiation, and Messrs. H. P. Walmsley and W. Makower show that the path of an α particle projected along a photographic plate is visible on development, and may be used to study the scattering of the particles by matter.

A PAPER dealing with the design of floats for hydro-aeroplanes has been issued from the recently reopened Langley Aerodynamical Laboratory, and relates to experiments carried out on models in the naval tank at Washington. The results confirm those obtained elsewhere, and show that the float requiring least power for leaving the water is one with a V-shaped bow. Such a bow sends up a remarkable sheet of water which must be turned down again by the shoulder of the float if the best results are to be obtained. All the experiments were carried out with floats having a single step, and it is stated that the step should be well ventilated; air was allowed access

to the step through one or two passages from the upper surface of the float, but without the assistance of cowls to increase the air pressure, an assistance which has been found advantageous in the case of experiments made elsewhere. Reference is also made in the paper to the pitching moments which arise when a float having a single step is used, and it is pointed out that whilst getting up speed the air controls are ineffective at first, and to reduce the period of lack of effective control it is proposed to put the step near to the centre of gravity. Certain disadvantages of another kind are thereby introduced, and for various reasons the above position has not yet been accepted as the best by all designers of hydro-aeroplanes.

WE have received from Washington a "Classified List of Smithsonian Publications Available for Distribution, April 25, 1914," published by the Smithsonian Institution. The papers included in the list are distributed gratis, except as otherwise indicated. Applicants for the publications are asked to state the grounds for their requests, as the institution is able to supply papers only as an aid to the researches or studies in which applicants are especially interested.

THE Congress of Naval Architects at Newcastle during the present week is marked in *Engineering* for July 3 by a number of articles descriptive of Tyneside engineering and shipbuilding works. Among these is a description of the appliances used in testing turbo-dynamos at the Heaton works of Messrs. Parsons, the success of the Parsons turbine-driven electric machinery being largely a consequence of the experimental work carried out by aid of this installation, which now admits of extensive and accurate testing work being done. Provision is made for testing at full load for several hours continuously turbo-dynamos having an output of more than 3000 kw. There are three large water-tube boilers and one Lancashire boiler and a network of pipes arranged so that steam may be supplied to any of the numerous test-beds. A separately fired superheater is used, so that almost any desired degree of superheat can be obtained. There are two independent condensing plants. Two powerful Heenan and Froude water-brakes have been installed, with which geared turbines may be tested up to 3000 brake-horse-power.

THE eleventh volume of the Journal of the Institute of Metals has now been issued. The volume runs to 437 pages, and is divided into three sections. The first contains minutes of proceedings, and is concerned largely with the annual meeting held in London last March. The presidential address by Sir Henry J. Oram, K.C.B., is printed in full, and the papers read at the annual meeting are also included, together with reports from the institute's committees. The second section is made up of a valuable collection of abstracts of papers relating to the non-ferrous metals and the industries connected therewith. The third part contains the memorandum and articles of association and a list of members. The volume has been well edited by the secretary of the institute, Mr. G. S. Scott, and is published by the institute, Caxton House, Westminster, at the price of 21*s.* net.

OUR ASTRONOMICAL COLUMN.

A FAINT NEW COMET (1914*c*).—A Kiel telegram, dated July 1, announces the discovery by Neujmin of a new comet on June 29 at 13h. 35·3 Simeïs mean time. It is stated to be of magnitude 12, and its position is given as R.A. 18h. 5m. 24s., and declination 12° 55′ S.

A further telegram from Kiel, dated July 2, gives Dr. Graff's observation of this comet on July 1 at 11h. 56·4m. Bergedorf mean time. Its magnitude is given at 12·5, and its position, R.A. 18h. 3m. 17·5s., and declination 12° 26′ 44″ S. A supplement to the *Astronomische Nachrichten* (No. 4747) gives some further positions. Aitken and Tucker observed the object with the 36-in. refractor on July 1 at 12h. 13·1m. Mount Hamilton mean time, and gave the position R.A. 18h. 2m. 52·5s., and declination 12° 21′ 29″ S. Graff and Schorr on July 2, at 11h. 36·5 Bergedorf mean time, state the object to be of magnitude 12·5, and situated at R.A. 18h. 2m. 13·2s., and declination 12° 12′ 53″. The comet is at present situated in the constellation of Serpens, and is a little south of Eta.

OPPOSITION OF EROS (433) THIS YEAR.—While the opposition of Eros, which will occur on September 18 of the present year, is not a very favourable one as regards its distance from the earth, Prof. E. C. Pickering directs attention to the occasion for pursuing a photometric study (Harvard College Circular, No. 183). By the courtesy of Prof. Cohn, director of the Recheninstitut, Prof. Pickering publishes the ephemeris and other data concerning this object from June 30 to the end of the year, to assist those making observations. The author publishes the interesting statement regarding a reduction now in hand of a large series of observations made by the late Oliver C. Wendell, which has indicated a new fact in the photometry of asteroids. It appears that Eros in 1898 was more than a magnitude fainter than in 1900. Similar changes occurred in other asteroids, as was shown in the case of Juno (3) (Har. Ann., xlvi., 201). When all the corrections are applied for distances from the sun and earth, for phase, and for variation due to rotation, another large source of variation is still apparent the cause of which is difficult to explain. Prof. Pickering emphasises this as an additional reason why observations both of the relative and absolute magnitude of Eros should be made this year.

RECENT PUBLICATIONS OF THE ALLEGHENY OBSERVATORY.—Dr. Frank Schlesinger and Mr. Charles J. Hudson give the results of a preliminary investigation (vol. iii., No. 9) regarding the determination of star positions by means of a wide-angle camera. The object of the research was to find a method of charting stars which would overcome the difficulty of insufficient comparison stars; the employment of a wide-angle camera will permit of a larger area of the sky being photographed on one plate. So far as the investigation has gone, the doublet used is considered well adapted for cataloguing purposes, and it covers a field of 25 square degrees, as compared, for example, with the 4 square degrees in the case of the plates for the Astrographic Catalogue. In another number (vol. iii., No. 11) Dr. Schlesinger gives a description with two plates of a large screw-measuring engine designed for taking plates of all sizes up to 8 × 10 in., and adapted to the measurement of stellar and solar spectrograms, as well as ordinary celestial photographs. The engine seems to have given great satisfaction, both for its convenience and accuracy of performance. Nos. 10 and 12 of the same publication give the orbits of the variable stars 18 Aquilæ and

88*d* Tauri respectively, the individual authors being Mr. F. C. Jordan and Mr. Zaccheus Daniel.

THE VARIABLE SATELLITES OF JUPITER AND SATURN.—*Astronomische Nachrichten* (No. 4741) is composed almost wholly of a long communication by Dr. P. Guthnick on the variable satellites of Jupiter and Saturn, treated as planetary analogies of variables of the δ Cephei type. The photometric observations here discussed deal with the observations he has made since the end of the year 1904 at the Bothkamp, and later at the Berlin, Observatories. The satellites included the four old ones of Jupiter, and Enceladus, Tethys, Dione, Rhea, Titan, and Iapetus of Saturn, in all ten objects, measured with the Zöllner photometer on refractors of 6-, 9-, and 11-in. aperture. Dr. Guthnick accompanies his paper with thirty-five curves of nine satellites, and compares them with each other. Among the deductions he draws may be mentioned that the inner satellites of both systems, Jupiter I. and II., Tethys and Dione, exhibit a principal maximum about the time of easterly elongation; in fact, all the light curves are very similar in their chief features. The outer satellites of both systems, Jupiter IV., and especially Iapetus, show, on the other hand, a very pronounced maximum in the neighbourhood of the westerly elongation. The middle satellites, Jupiter III., Rhea, and Titan, belong partly to the first and partly to the second group, or, in other words, exhibit an uncertain type. Dr. Guthnick refers at some length to the observations and deductions of Auwers, Engelmann, Pickering, Searle, Upton, Wirtz, etc., and gives some interesting tables, including one displaying the mean brightnesses at opposition, values of the albedo, masses and densities of the satellites of Jupiter and Saturn.

THIRD INTERNATIONAL CONGRESS OF TROPICAL AGRICULTURE.

THIS congress opened at the Imperial Institute on Tuesday, June 23, and sat daily, except on Saturday and Sunday, until Tuesday, June 30. The number of Governments and societies represented by delegates were forty-two and forty respectively, and the total number of members and delegates was about four hundred. In these respects and also as regards the number and quality of the papers read, the London Congress showed a very great advance on the previous congresses, held in Paris and Brussels.

Education and Research in Tropical Agriculture.

Perhaps the most interesting tendency exhibited by those who read papers and took part in the discussions was that of insisting on the necessity for a better organisation of education and research in tropical agriculture. This note was struck in Prof. Dunstan's presidential address, but it was particularly satisfactory to hear it not only from a man of science such as the president, but also at meetings afterwards from practical planters and manufacturers, and from men who have held high administrative posts in the tropical colonies. The necessity for higher education in tropical agriculture was felt so strongly, that at its concluding meeting the congress passed unanimously a resolution instructing the general committee of the congress to cooperate with the London committee, which is now promoting the establishment of a higher Agricultural College in the British tropics.

On the question of better provision for research in tropical agriculture, the congress contented itself with appointing a committee to collect precise information regarding the organisation, work, and cost of agricultural departments in the tropics, with a view to more definite recommendations being made at a future congress.

A British Institute of Tropical Agriculture.

Closely connected with these questions of education and research is that of providing a permanent organisation to promote and safeguard the interests of those engaged in the higher branches of tropical agricultural work, and the congress cordially endorsed the suggestion made in the president's address that a British Institute of Tropical Agriculture should be founded. At the concluding meeting a resolution instructing the general committee of the congress to take the action necessary to this end, was adopted unanimously.

Social and Economic Questions.

The social and economic problems which arise in the practice of tropical agriculture are even more difficult and complex than those with which everyone in this country is familiar in connection with the home agricultural industry. The Brussels Congress gave special attention to the question of the supply of native labour in the tropics, and the reports on this subject collected for that congress are now in the press. The London Congress discussed two problems of this kind, viz., "Agriculturai Credit Banks and Cooperative Societies," and "Sanitation on Tropical Estates." Sir Horace Plunkett took the chair at the former discussion, and a very interesting paper was read by Sir James Douie, giving an account of his experience of the working of such banks and societies in India, and more particularly in the Panjab. This formed the basis of a discussion which terminated in the adoption of a resolution by the congress to collect information and prepare a report on the working of such banks and societies in tropical countries. A paper on tropical hygiene and plantation work in the Federated Malay States, by Dr. Sansom and Mr. F. D. Evans, formed the basis of the second discussion, at which Sir Ronald Ross presided. In this case also the congress decided to appoint a committee to collect information and prepare a report, on the preventive measures possible against ankylostomiasis, cholera, dysentery, malaria, smallpox, and other diseases prevalent amongst native labourers on tropical estates.

On the same morning the congress also discussed the relation of the Phytopathological Convention of Rome to tropical agriculture, on a paper read by Mr. A. G. L. Rogers, of the Board of Agriculture. A considerable number of entomologists and mycologists working in agricultural departments in the tropics were present, and some of them were of opinion that the convention was not altogether suitable for adoption in the tropics. The discussion on this subject was resumed at the concluding meeting of the congress on a motion by Mr. E. E. Green (late of Ceylon) and Dr. Gough, of the Egyptian Ministry of Agriculture, that the congress should appoint a committee to consider how far the proposals in question are applicable to tropical countries, and on the suggestion of M. Brenier, of Indo-China, a rider was added to this motion that the Government delegates present should communicate this resolution to their Governments as soon as possible.

An interesting discussion also took place on a motion by Sir James Wilson and Sir Sydney Olivier on the subject of the support of the International Institute of Agriculture at Rome by tropical countries, in which a large number of members took part. A resolution was finally adopted, by which the congress decided to ask the committee of the congress to consider the whole question of cooperation with the International Institute of Agriculture.

Technical Problems.

The tropical crops which chiefly claimed the attention of the congress were rubber and cotton, one day being devoted wholly to the former and one and a half days to the latter. A good deal of discussion took place with regard to the alleged variation in the properties and quality of plantation Para rubber. The discussion made it clear that at present each manufacturer seems to have set up for himself an empirical standard of quality for plantation rubber, and that it is very desirable that some generally accepted standard should be adopted. A number of papers on the cultivation of Ceara, Castilloa, and other rubber-yielding species in various countries were also read, and Messrs. Petch and Green contributed interesting and useful papers on the tapping of Hevea and on the insect pests of Hevea respectively.

A series of papers on cotton was read dealing with almost every phase of this important subject, such as the breeding of new cottons, the selection of cotton-seed, the technical qualities which manufacturers require in new cottons, the methods of investigating cottons, and so on. One of the most interesting contributions on cotton was that by Lord Kitchener describing the successful reclamation of a large area of salt land in the Egyptian delta and its utilisation for cotton growing. Equally useful was the address delivered by Mr. Harcourt, Secretary of State for the Colonies, describing the work of the Imperial Institute, the British Cotton Growing Association, the Colonial Departments of Agriculture and other bodies, which under the direct control of the Colonial Office, or with its active sympathy and support, now further in every possible way the cultivation of cotton within the Empire.

The various subjects alluded to above occupy such an important place in every tropical country that a large proportion of the time of the congress was devoted to them, but time was also found for the discussion of a number of subjects which are of special importance to certain countries. Thus Prof. Carmody, of Trinidad, contributed a most interesting account of the experiments on cocoa cultivation and preparation now in progress in that island, and useful contributions on this subject were also made by Messrs. Johnson, Tudhope, van Hall, Booth and Knapp, and others.

Wheat is as yet scarcely regarded as a tropical crop, and Mr. A. E. Humphries's paper on the possibilities of wheat production in the tropics, no less than that of M. Baillaud on the wheats of Tunis and Algeria, was a revelation to many members of the congress of new and unsuspected areas suitable for wheat cultivation.

Herr Hupfeld's paper on the oil palm in the German colonies was another contribution of which special mention may be made, since it gave an authentic account of the actual operation of European machinery in West Africa in the extraction of palm oil, an innovation which is likely to revolutionise this immense industry, which has hitherto been conducted by natives using most primitive and wasteful methods.

In conclusion mention may be made of the hospitality extended to the members and delegates. H.M. Government gave a dinner to the foreign delegates and a reception for all the members and delegates on the evening of June 23. Both these functions took place at the Imperial Institute. On Saturday, June 27, a selected party of members and delegates was invited by the Duke of Bedford to visit the Woburn Experimental Farm, and by the Lawes Agricultural Trust to visit Rothamsted. The party exhibited great interest in the experiments in progress at both stations, which were explained to them by Mr. S. U. Pickering and Dr. Russell. A party also visited Kew on the same day on the invitation of Sir David Prain. During the week receptions were held by the Royal Geographical Society, the Royal Colonial Institute, and the Rubber Growers' Association, all of which were largely attended by members and delegates of the congress.

INTERNATIONAL COMMISSION FOR SCIENTIFIC RADIO-TELEGRAPHIC RESEARCHES.

THE idea of forming an International Commission for the scientific study of questions relating to wireless telegraphy arose from a conversation between Prof. Schmidt and Mr. Goldschmidt, at the International Time Conference in Paris in 1912. Representatives from various countries held a meeting in Brussels in October, 1913, at which a provisional committee was appointed and the general lines of the scheme for the organisation of the working were drawn up. It was decided to send out from the high-power station at Laeken, near Brussels, radio-telegraphic emissions at regular intervals, and that these emissions should be observed and measured by experimenters in Belgium and in other countries.

The commission held a sitting on April 6 at Brussels, under the presidency of Mr. Duddell, at which the commission was constituted definitely. The results already obtained were discussed and arrangements made for future experiments.

National committees, which formed part of the organisation of the International Commission, have been constituted in Belgium, France, and Great Britain. In Germany, many stations have agreed to receive the signals, and a more complete organisation will be formed soon. National committees are also in course of formation in Austria, Russia, Italy, Switzerland, etc.

At the last meeting it was decided to cooperate so far as possible with the work of the Committee for Radio-telegraphic Investigation of the British Association, and the scope of the work was set out.

A demonstration of the methods of emission and measurement in use at the high-power station at Laeken, Brussels, took place before the commission, and reports were read on changes that had been made and on future alterations. The improvements consisted mainly in the use of a new spark-gap having a great damping, and in increasing the extent of the antenna and of the amount of energy radiated.

Arguing from a comparison of the signals received from Brussels, Norddeich, and Paris, Prof. Wien pointed out that there appeared to be difficulties with the present spark circuit, and he expressed the wish that tests should be made with the continuous-wave system. The commission decided that a small high-frequency alternator should be acquired, considering that larger machines are not developed sufficiently yet to warrant the expense.

Reports were read on the photographic registration of signals and other subjects. The reports led to a discussion on the strength of the signals received at the various receiving stations, and the commission expressed the wish that the experimenters should send in, with the results of their experiments, the characteristics of their antenna, and that, whenever possible, they should employ photographic registration.

Mr. Duddell read a paper with regard to the methods and instruments to be employed at the different stations, and other communications were dealt with.

The officers of the commission, provisionally elected at the first meeting, were confirmed as follows:—President, Mr. Duddell; vice-president, Mr. Wien; general secretary, Mr. Goldschmidt; assistant secretary, Mr. R. Braillard.

THE RESEARCH DEFENCE SOCIETY.

THE annual general meeting of the Research Defence Society was held last week at the Royal Society of Medicine. About 160 persons were present, among them Sir William Osler, Sir John Tweedy, Sir David Ferrier, Prof. Cushny, Sir James Reid, Sir Charles Dalrymple, Sir John Brunner, Sir Hugh Bell, and Sir Francis Champneys. Expressions of regret for non-attendance were received from Mr. Waldorf Astor, Mr. Arthur Balfour, Lord Bath, the Dean of Canterbury, Lord Hugh Cecil, Lord Cromer, Sir Francis Darwin, Lord Faber, Lord Farrer, Bishop Frodsham, Mr. Walter Guinness, Lord Claud Hamilton, Sir John Prescott Hewett, Lord Kilmorey, Sir Norman Lockyer, Mr. Walter Long, Prof. Howard Marsh, Lord Northbrook, Sir Gilbert Parker, Sir Frederick Pollock, Sir William Ramsay, Lord Rayleigh, Sir Henry Roscoe, Lord Salisbury, Lord Sheffield, Sir Edgar Speyer, the Bishop of Stepney, Sir Frederick Treves, and Mr. Henry S. Wellcome. The chair was taken by the president, Lord Lamington.

Lord Knutsford, chairman of committee, presented the reports of the society. He referred to the Dogs Protection Bill, pointing out that such a Bill might have prevented the discovery of a cure for distemper; and he directed attention to the educational work of the society. "We are trying, trying, to make the truth understood."

The president then gave his address. After a reference to his predecessors in office, Lord Cromer and the late Sir David Gill, "Our society," he said, "is really a protecting guard for science, in its noblest form, against those who, whilst we can respect their feelings and desires, are led by their emotions rather than by their reason." We should look around, to see what other nations were doing. All nations were engaged in research involving experiments on animals, and that, in most instances, without any legal restriction. "That is a system of which I am sure this country would not approve. Our desire is to reduce human and animal suffering, and on no account to encourage any practice which could possibly tend to permit callousness or indifference to the pain suffered by others. I cannot help thinking that it is this idea which is at the back of the mind of anti-vivisectionists: it is the dislike of seeing human beings engaged in any undertaking involving pain, and the fear of its thereby hardening or debasing human character. It is not merely the fact of pain being inflicted upon the animal, but the fear of the reactive effect on the mind of the person who inflicts the pain. For instance, we should term a farmer, who chose a pet lamb to be killed, rather than one out of his flock, a man of brutal character; yet the pain to the animal would be alike in either case."

Speaking of pain in the animal world, "I may be wrong," he said, "but I am honestly convinced that it is not physical pain that causes the greatest amount of suffering to animals; it is when their instinct of self-preservation takes alarm that they suffer. Anyone who has seen wounded wild animals must have noticed how, when unalarmed, they appear indifferent to their wounds. It is only when their instinct of self-preservation is aroused, and they become aware of their disablement, that they seem to suffer. . . .

"I wish here to say, most emphatically, that the chief business of our society is not mere fighting. It is the quiet, steady educating of public opinion as to the true character and method of experiments on animals in this country, and the great advantages which these experiments give, not only to human life, but to the life and health of the higher domestic animals."

A vote of thanks was proposed by Sir Reginald Talbot, seconded by Dr. Sandwith. After the meeting, there was a demonstration with the kinematograph of living germs of cholera, typhoid, sleeping sickness, etc.

THE SYNTHETIC POWER OF PROTOPLASM.[1]

FROM the point of view of the biological chemist the phenomena of life are manifestations of interactions of colloidal and crystalline materials in a peculiarly organised solution; over and above this every form of protoplasm, existent in any organism, is stereochemically ordered in specific relationship to that organism, so that the products of synthesis have an impressed structure and manifest optical activity. It has been suggested by Prof. Armstrong that the protoplasmic complex may be regarded as built up of a series of associated templates which serve as patterns against which change takes place in the various directions necessary for the maintenance of vital processes. This view is based on the well-known relationship between an enzyme and its hydrolyte; the synthetic enzymes, it may be supposed, serve as patterns for the elaboration of complex materials of definite pattern from the simple units.

In speculating on the origin of organic life from inorganic material Prof. B. Moore has ignored this stereochemical aspect of the question. His use of the well-known synthesis of formaldehyde from carbon dioxide and water in presence of an inorganic catalyst—in his case a colloid—can lead only to optically inactive material, and there is no justification even for the mention of the term life until evidence of directed synthesis is adduced.

The stereochemical hypothesis enunciated has been advocated by Prof. Reichert, of Pennsylvania, in his researches on hæmoglobin, in which he showed that this substance is modified in specific relationship to genus and species. He now extends the hypothesis to the study of starch, expecting that the peculiarities of the protoplasm in different species of plants will occasion the formation of different types of starch. The variations in the starch granule with origin are, of course, well known, and they are of industrial importance. They are now shown to be absolutely diagnostic in relation to the plant and to constitute a strictly scientific basis for the classification of plants. In addition to recording the microscopic characters of the starches an attempt has been made on a large scale to characterise them chemically, and although these tests are admittedly crude and leave much to be desired, they do mark a great advance in the treatment of the subject.

It may be regarded as established that starches of different origin vary both visibly and in chemical properties; moreover, plants of closely allied species contain starches with similar properties, and it is logical that such variations must be attributed to the differences of protoplasmic influence under which the starch granules are formed. It must not be overlooked, however, that starch granules are made up of three kinds of substances, namely, the true

[1] "The Differentiation and Specificity of Starches in Relation to Genera, Species, etc." Stereochemistry Applied to Protoplasmic Processes and Products, and as a Strictly Scientific Basis for the Classification of Plants and Animals. By Prof. E. T. Reichert. In two parts. Pp. xvii+900+102 plates. (Washington, D.C.: Carnegie Institution of Washington, 1913)

starch degradable to maltose, which forms the bulk of the granule, amylocellulose or amylopectin, and a small proportion of carbohydrate, possibly crystalline, soluble in cold water. It is probable that these are present in different proportions in the various starches, and so give rise to such differences as Reichert has observed.

Some valuable observations on the characters of hard and tender barleys, published H. C. A. Vine in the Journal of the Institute of Brewing, may be mentioned in this connection. A barley corn may contain starch granules of all sizes, the variation being due to the conditions under which it develops. Malnutrition of barley leads to a high ratio of small starch granules which are more resistant to enzyme action, to moisture, and to heat than the normal mature granules. Those granules which have the more favourable position in the enclosing cell are able to appropriate a large proportion of the nutriment supplied by the protoplasm, and so become normal large starch granules, each consisting of many layers containing much granulose, tender and readily acted upon.

Similar observations were made by the writer some years back when it was pointed out that there is considerable variation in the proportion of large to small granules in wheat starch. Those types of flour which are the best for certain purposes contain the greatest proportion of large granules, the property being quite characteristic.

Hence it would seem that, over and above species variation, differences due to environment and nurture may appear in the starches, and it is possible that the further study of such a substance as starch may provide material for the solution of many vexed problems.

In addition to the detailed account of the tests applied to each starch, which are recorded also in the form of a curve which is shown to be characteristic for each individual, Prof. Reichert includes in his book a beautiful series of photomicrographs taken in ordinary and polarised light. These enhance very materially the value of the work, although they must have increased greatly the cost of publication. The author has further been at pains to summarise at some length previous work on starch, both on the chemical and on the botanical side. His account is a valuable one if only as showing how much uncertainty exists at present in the knowledge of starch and its transformations. E. F. A.

TRANSPIRATION IN PLANTS.

TWO paper by Sir Francis Darwin (Proceedings of the Royal Society, B, vol. lxxxvii.) mark an important advance in the study of the process of transpiration in plants. Hitherto, although transpiration is perhaps more directly under the rule of external physical conditions than any other physiological function of plants, there has been no complete experimental demonstration of the relation between the loss of water-vapour from leaves and the relative humidity of the air or of the effect on transpiration of variation in the illumination to which the leaf is subjected. These lacunæ are due to the fact that transpiration depends largely on the opening and closing of the stomata, the aperture of which varies in area with varying external conditions. To eliminate from the problem the varying stomatal aperture, the author blocks the stomata by smearing the leaf with cocoa-fat or vaseline, and then makes incisions which place the intercellular spaces in communication with the atmosphere; by measuring the thickness of the leaf and making incisions of a certain total length, the area thus exposed is made to correspond with the area of the stomatal apertures under ordinary conditions. By using this ingenious method, the author finds that the line joining the abscissæ representing the transpiration for different degrees of atmospheric humidity is practically straight, but that the transpiration begins at about 5 per cent. above saturation, and from calculation of the vapour pressures at saturation and this degree of supersaturation, it appears that the internal temperature of the leaf which can distil off vapour in saturated air is about 1° C. above that of the air, this increased temperature being attributable to respiration.

The second paper gives the results obtained by applying this method to the investigation of the effect of light on transpiration. In April the transpiration of ivy was the same in diffused daylight and in darkness, while a month later the transpiration in light was double that in darkness, but the average ratio for transpiration in light and darkness was 135 : 100, though between May 14 and June 16 the laurel gave an average 150 : 100. The cause of the increased reaction to illumination in early summer as compared with spring is not completely explained, the author having no evidence as to whether the increased permeability of the leaves to water is a periodic effect, or connected with the age of the leaf, or with the brightness of the summer sky, as compared with illumination earlier in the year.

THE AMERICAN PHILOSOPHICAL SOCIETY.

THE annual general meeting of the American Philosophical Society was held in Philadelphia on April 23–25 inclusive, when numerous papers embodying the results of original researches were read. It is possible here to refer only to the more important and to those of wide scientific interest.

The president, Dr. William W. Keen, was in the chair at the opening meeting, and among the papers presented was one on the segregation of "unit characters" in the zygote of Œnothera with twin and triplet hybrids in the first generation, by Prof. G. F. Atkinson, Cornell University. The segregation of several distinct hybrid types in the first generation of a cross between two species is a rare phenomenon. In Prof. Atkinson's experimental studies, the two parents are *Œnothera nutans* and *Œ. pycnocarpa*, wild species of the evening primrose in the vicinity of Ithaca, N.Y. They differ by more than thirty easily recognisable contrast pairs of "unit characters," or, in terms of the "presence and absence" hypothesis, there are more than sixty "factors" or recognisable characters which meet in the fertilised egg of the cross between the two parents. These characters relate to the habit and colour of the adults, features of the rosettes, foliage, and inflorescence. When *pycnocarpa* is the mother, two distinct hybrid types are segregated in the first generation, and have been brought to maturity. These are "twin hybrids." When *nutans* is the mother, the same twin hybrids appear, and, in addition, a triplet which at present is in the rosette stage.

The analysis of the hybrids shows a distinct linking or association of certain characters. Examples of this linking of characters are as follows:—First, habit characters; secondly, colour characters; thirdly, petal characters; fourthly, broadness and toothedness of rosette leaves; fifthly, narrowness and cutness of rosette leaves; sixthly, crinkledness, convexity, and red-veinedness of rosette leaves; seventhly, plainness, furrowedness, and white-veinedness of rosette leaves.

The following hypotheses are considered:—(1) De

Vries's hypothesis of twin hybrids from mutating species; (ii) theory of a differential division in the zygote; and (iii) the reaction theory.

A paper on the vegetation of the Sargasso Sea was contributed by Prof. W. G. Farlow, of Harvard University. The Sargasso Sea is characterised by the scattered masses of gulf weed which float on the surface of the ocean in patches from 50 to 100 ft. in diameter. Some consider that the gulf weed, *Sargassum bacciferum*, is merely a mass of sterile branches of some species of Sargassum, which grows attached in the region of the West Indies, and fruits. Others believe that in its present floating form it is a distinct species which has lost the power of fruiting and increases only by offshoots. In recent years the species of Sargassum growing in different parts of the West Indies have been studied, and a comparison with the floating gulf weed shows that mixed with it are found fragments of at least two species known to grow in the West Indies. In only one instance has there been found mixed with the gulf weed a seaweed which must have come, not from the American coast, but from Africa or southern Europe. There is reason to think that the gulf weed is derived from some Sargassum growing in the West Indies, fragments of which are carried by the Gulf Stream to the Sargasso Sea.

On April 24 a paper on phase changes produced by high pressures was read by Mr. P. W. Bridgman, of Harvard University. Pressures as high as 30,000 or 40,000 kgm. per sq. cm. were employed. Examination of the melting of a number of liquids over a wide pressure range has shown that the theories hitherto proposed do not hold at high pressures. So far as can be judged the melting curve continues to rise indefinitely, so that a liquid may be frozen by the application of sufficient pressure, no matter how high the temperature. A number of results are also obtained for the reversible transition from one crystalline form to another. Several new solid forms have been obtained; of particular interest are the new forms of ice which are denser than water. In addition to these changes, which are completely reversible, one example has been found of an irreversible reaction produced by high pressure; yellow phosphorus may be changed by 12,000 kgm. and 200° to a modification in appearance like graphite, which is 15 per cent. more dense than the densest red phosphorus.

Prof. R. A. Millikan, of the University of Chicago, read a paper on some new tests of quantum theory and a direct determination of h. It has been known for twenty-five years that when light of sufficiently short wave-length falls upon a metal, it has the power of ejecting electrons from that metal. It has been known for seven years that the kinetic energy possessed by the electrons thus ejected is larger the higher the frequency of the light which ejects them. Whether or not the energy of ejection is directly proportionate to frequency has been a matter of some uncertainty. Prof. Millikan's work furnishes proof that there is exact proportionality between the energy of the ejected electrons and the frequency of the light which ejects them, and that the factor of proportionality between the energy of the ejected electrons and the frequency of the incident light is the same quantity as the fundamental constant which appears in Planck's theory of the discontinuous or explosive character of all radiant energy of the electromagnetic type. This constant is known as Planck's h, and its value is directly determined with an error which does not exceed 1 per cent.

Dr. Charles F. Brush, of Cleveland, discussed "A Kinetic Theory of Gravitation: (1) Gravitation is Due to Intrinsic Energy of the Æther; (2) Transmission of Gravitation cannot be Instantaneous." He employs illustrations to show that the energy acquired by falling bodies has some *external* source, and that it must be ætherial energy or energy of space; and he holds that the term "potential energy of position," as applied to a system of gravitating bodies, implies the energy-endowed æther as a necessary part of the system. As a corollary, he explains how bodies falling toward each other by reason of their mutual attraction, and thus *accelerating*—that is to say, absorbing energy from the æther—cannot rigidly obey Newton's law of inverse squares of distance. In the second division of the paper the premises from which Laplace drew his famous conclusion that gravitation is transmitted with infinite, or virtually infinite, velocity, are described, a dogma which, said Dr. Brush, "for more than a century has blocked the path of fruitful thought on the physics of gravitation." It is concluded that, even if the velocity of transmission is no greater than that of light, the moon's mean motion will be *retarded* a very few seconds of arc only, in a century; and the retardation will be correspondingly less if the velocity is greater than that of light. This retardation, of course, adds to the unexplained acceleration, if any, of the moon's motion; but the author further hopes that this retardation, plus the outstanding acceleration, will be explained by a particular deviation from Newton's law described.

Prof. W. Duane, of Harvard University, presented a contribution on highly radio-active solutions. The advantage in using these solutions in studying the effects produced on tissues is that after injection the radio-active substances come into intimate contact with the tissues, and thus the full power of the alpha rays is utilised. If a solution of radium itself is injected, the process is not only costly, but dangerous, on account of the long life of the radium. The solutions do not have these objections, for the radium is not wasted in producing the solutions, and the activity lasts for only a short time. If the injection is made subcutaneously, a large fraction of the activity remains in the neighbourhood of the point of injection, and the rest is carried off in the lymph and blood streams. The rapidity with which the activity gets into circulation is astonishing. A drop of blood taken from another part of the body only a few seconds after the injection is more radio-active than carnotite or pitchblende ores. It would seem that this might prove to be a delicate method of studying the flow of fluid through the tissues. On making tests by means of the gamma rays an hour or an hour and a half after the injection it was found that there was very little activity in the brain and lungs, but that there was a tendency for the substances to deposit out in the liver, spleen, and kidneys.

"The Relations of Isostasy to a Zone of Weakness—the Asthenosphere," was the subject of a paper by Prof. J. Barrell, of Yale University. The mass of every mountain tends to deflect the plumb-line slightly, so that the measured latitude and longitude of any locality will differ as it is determined by triangulation or by astronomic determination of the point in which the observed vertical pierces the celestial sphere. But Hayford has shown that the deflections of the vertical are actually only one-tenth of the deflections calculated as due to the terrestrial relief. This is a quantative test of the degree of isostasy. Dynamically it implies a state of flotation of the crust upon the inner earth analogous to the flotation of an iceberg in the ocean. Yet the earth as a whole is known to be as rigid as steel; the nature of earthquake vibrations transmitted through the earth shows it to be solid throughout and more incompressible and rigid at great depths than near the surface. How, then, shall the geodetic

evidence pointing toward a general flotation of the crust near to equilibrium be reconciled with this other evidence of great rigidity and strength? It has been supposed that a mobile zone may explain the apparent contradiction, but the necessity of postulating such a zone becomes greater as the accumulated evidence of weakness on one hand, of strength on the other, diverges more and more. By means of a study of the areas of the surface loads and their degree of departure from isostatic equilibrium this zone is located far deeper than other estimates have placed it, the level of minimum strength being thought to lie as much as 150 to 200 miles deep. The maximum strength is probably at a depth of ten to twenty miles, and falls off rapidly below.

"The Geologic and Biologic Results of a Study of the Tertiary Floras of South-eastern North America" were presented by Prof. E. W. Berry, of Johns Hopkins University. The results of many years of study of the rich Tertiary floras of south-eastern North America were announced for the first time. Their botanical relationships and their bearing on the evolution of types and upon geographical distribution were summarised. The studies have afforded for the first time fossil floras of fixed stratigraphic position for comparison with the floras of the Rocky Mountain province on the border between the Cretaceous and Tertiary, the age of which has caused much controversy. They also afford means for correlation with the type of section of the Paris basin.

During the afternoon of April 24 a portrait of the late Dr. S. P. Langley, who was a former vice-president, was presented to the society by Dr. C. Adler on behalf of a number of members. On April 25 the following new members were elected as the result of balloting,—Mr. C. G. Abbot, Washington; Dr. J. W. Bright, Baltimore; Dr. B. M. Davis, Philadelphia; Dr. T. McCrae, Philadelphia; Dr. W. D. Matthew, New York; Dr. A. G. Mayer, Washington; Dr. S. J. Meltzer, New York; Dr. J. C. Merriam, Berkeley, Cal.; Prof. R. A. Millikan, Chicago; Prof. W. A. Noyes, Urbana, Ill.; Dr. Stewart Paton, Princeton; Dr. R. M. Pearce, jun., Philadelphia; Dr. P. C. Ricketts, Troy; Dr. Harold A. Wilson, F.R.S., Houston; Dr. F. E. Wright, Washington; Dr. Shibasaburo Kitasato, Tokyo; Prof. H. Kamerlingh Onnes, Leyden; and Dr. Vito Volterra, Rome.

At the concluding session of the meeting a medallion portrait of the late Sir Joseph D. Hooker was unveiled by Prof. W. G. Farlow, of Harvard University.

X-RAYS AND CRYSTALLINE STRUCTURE.[1]

TWO years have gone by since Dr. Laue made his surprising discovery of the interference effects accompanying the passage of X-rays through crystals. The pioneer experiment has opened the way for many others, and a very large amount of work, theoretical and practical, has now been done. As the preliminary exploration of the new country has proceeded our first estimate of its resources has grown continuously; we have learnt many things which help us to a better understanding of phenomena already familiar, and we have seen avenues of inquiry open out before us which as yet there has been little time to follow. The work is full of opportunities for exact quantitative measurement, where precision is sure to bring its due reward. There is enough work in sight to absorb the energies of many experimenters, and there is sure to be far more than we can see. When we consider the wideness of the new field, the quality and quantity of the work to be done in it, and the importance of the issues, we are scarcely guilty of over-statement if we say that Laue's experiment has led to the development of a new science.

The experiment itself—to put it very briefly—constitutes a proof that X-rays consist of extremely short æther waves. In order to appreciate the value of this demonstration, we must bear in mind the present conditions of our knowledge of the laws of radiation in general. Let us consider very shortly how the whole matter stood when the new work was begun.

When X-rays were first discovered eighteen years ago it was soon pointed out that they might consist of electromagnetic disturbance of the æther analogous to those supposed to constitute light. It was true that the new rays seemed to be incapable of reflection, refraction, diffraction and interference which were familiar optical phenomena. But it was pointed out by Schuster (NATURE, January 23, 1896) that these defects could be explained as natural consequences of an extremely small wave-length. The positive evidence consisted mainly in the knowledge that the impact of the electrons on the antikathode of the X-ray bulb ought to be the occasion of electromagnetic waves of some sort, and in the discovery by Barkla that the X-rays could be polarised, which last is a property also of light.

As experimental evidence accumulated, a number of results were found which the electromagnetic theory was unable to explain, at least in a direct and simple manner. They were mainly concerned with the transference of energy from place to place. In some way or other the swiftly moving electron of the X-ray bulb transfers its energy to the X-ray, and the X-ray in its turn communicates approximately the same quantity of energy to the electron which originates from matter lying in the track of the X-ray, and which is apparently the direct cause of all X-ray effects. Experiment seemed to indicate that X-ray energy travelled as a stream of separate entities or quanta, the energy of the quantum differing according to the quality of the X-ray. It looked at one time as if it might be the simplest plan to deny the identity in nature of X-rays and light, to describe the former as a corpuscular radiation, and the latter as a wave motion. Otherwise it seemed that the electromagnetic hypothesis would be torn to pieces in the effort to hold all the facts together.

But it appeared on a close examination of light phenomena also, though in much less obvious fashion, that the very same effects occurred which in X-rays were so difficult to explain from an orthodox point of view. In the end it became less difficult to deny the completeness of the orthodox theory, than the identity in nature of light and X-rays. Modern work on the distribution of energy in the spectrum, and the dependence of specific heat upon temperature have also led independently to the same point of view. It has been urged with great force by Planck, Einstein, and others that radiated energy is actually transferred in definite units or quanta, and not continuously: as if we had to conceive of atoms of energy as well as of atoms of matter. Let it be admitted at once that the quantum theory and the orthodox theory appear to stand in irreconcilable opposition. Each by itself correlates great series of facts; but they do not correlate the same series. In some way or other the greater theory must be found, of which each is a partial expression.

The new discovery does not solve our difficulty at once, but it does two very important things. In the first place, it shows that the X-rays and light are identical in nature; in fact, it removes every difference except in respect to wave-length. The question as to the exact place where the difficulty lies is decided for us; we are set the task of discovering how a continuous wave motion, in a continuous

[1] Discourse delivered at the Royal Institution on June 5 by Prof. W. H. Bragg, F.R.S.

medium can be reconciled with discontinuous transferences of radiation energy. Some solution there must be to this problem. The second important thing is that the new methods will surely help us on the way to find that solution. We can now examine X-rays as critically as we have been able to study light by means of the spectrometer. The wave-length of the X-ray has emerged as a measurable quantity. The complete range of electromagnetic radiations now lies before us. At one end are the long waves of wireless telegraphy, in the middle are, first, the waves of the infra-red detected by their heating effects, then the light waves and then the short waves of the ultra-violet. At the other end are the extremely short waves that belong to X-radiation. In the comparative study of the properties of radiation over this very wide range we must surely find the answer to the greatest question of modern physics.

So much for the general question. Let us now consider the procedure of the new investigations, and afterwards one or two applications to special lines of inquiry.

The experiment due to Laue and his collaborators Friedrich and Knipping has already been described in this lecture-room, and is now well known. A fine pencil of X-rays passes through a thin crystal slip and impresses itself on a photographic plate. Round the central spot are found a large number of other spots, arranged in a symmetrical fashion, their arrangment clearly depending on the crystal structure. Laue had anticipated some such effect as the result of diffraction by the atoms of the crystal. His mathematical analysis is too complicated to describe now, and indeed it is not in any circumstances easy to handle. It will be better to pass on at once to a very simple method of apprehending the effect which was put forward soon after the publication of Laue's first results. I must run the risk of seeming to be partial if I point out the importance of this advance, which was made by my son, W. L. Bragg. All the recent investigations of X-ray spectra and the examination of crystal structure and of molecular motions which have been carried out since then have been rendered possible by the easy grasp of the subject which resulted from the simpler conception.

Let us imagine that a succession of waves constituting X-radiation falls upon a plane containing atoms, and that each atom is the cause of a secondary wavelet. In a well-known manner, the secondary wavelets link themselves together and form a reflected wave. Just so a sound wave may be reflected by a row of palings, and very short sound waves by the fibres of a sheet of muslin.

Suppose a second plane of atoms to lie behind the first and to be parallel to it. The primary wave, weakened somewhat by passing through the first plane, is again partially reflected by the second. When the two reflected pencils join it will be of great importance whether they fit crest to crest and hollow to hollow, or whether they tend to destroy each other's effect. If more reflecting planes are supposed, the importance of a good fit becomes greater and greater. If the number is very large, then, as happens in many parallel cases in optics, the reflected waves practically annul each other unless the fit is perfect.

It is easily seen that the question of fit depends on how much distance a wave reflected at one plane loses in comparison with the wave which was reflected at the preceding plane; the fit will be perfect if the loss amounts to one, two, three, or more wave-lengths exactly. In its turn the distance lost depends on the spacing of the planes—that is to say, the distance from plane to plane—on the wave-length and on the angle at which the rays meet the set of planes.

The question is formally not a new one. Many years ago Lord Rayleigh discussed it in this room, illustrating his point by aid of a set of muslin sheets stretched on parallel frames. The short sound waves of a high-pitched bird-call were reflected from the set of frames and affected a sensitive flame; and he showed how the spacing of the planes must be carefully adjusted to the proper value in relation to the length of wave and the angle of incidence. Rayleigh used the illustration to explain the beautiful colours of chlorate of potash crystals. He ascribed them to the reflection of light by a series of parallel and regularly spaced twinning planes within the crystal, the distance between successive planes bearing roughly the same proportion to the length of the reflected wave of light as the distance between the muslin sheets to the length of the wave of sound.

Our present phenomenon is exactly the same thing on a minute scale; thousands of times smaller than in the case of light, and many millions of times smaller than in the case of sound.

By the kindness of Prof. R. W. Wood I am able to show you some fine examples of the chlorate of potash crystals. If white light is allowed to fall upon one of them, the whole of it is not reflected. Only that part is reflected which has a definite wave-length or something very near to it, and the reflected ray is therefore highly coloured. The wave-length is defined by the relation already referred to. If the angle of incidence is altered, the wave-length which can be reflected is altered, and so the colour changes.

It is not difficult to see the analogy between these cases and the reflection of X-rays by a crystal. Suppose, for example, that a pencil of homogeneous X-rays meets the cube face of such a crystal as rock-salt. The atoms of the crystal can be taken to be arranged in planes parallel to that face, and regularly spaced. If the rays meet the face at the proper angle, and only at the proper angle, there is a reflected pencil. It is to be remembered that the reflection is caused by the joint action of a series of planes, which in this case are parallel to the face; it is not a reflection by the face itself. The face need not even be cut truly; it may be unpolished or deliberately roughened. The reflection takes place in the body of the crystal and the condition of the surface is of little account.

The allotment of the atoms to a series of planes parallel to the surface is not, of course, the only one possible. For example, in the case of a cubic crystal, parallel planes containing all the atoms of the crystal may also be drawn perpendicular to a face diagonal of the cube, or to a cube diagonal, or in many other ways. We may cut the crystal so as to show a face parallel to any series and then place the crystal so that reflection occurs, but the angle of incidence will be different in each case since the spacings are different. It is not necessary to cut the crystal except for convenience. If wave-length, spacing, and angle between ray and plane are rightly adjusted to each other, reflection will take place independently of any arrangement of faces.

This is the "reflection" method of explaining the Laue photograph. W. L. Bragg showed in the first place that it was legitimate, and in the second that it was able to explain the positions of all the spots which Laue found upon his photographs. The different spots are simply reflections in the different series of planes which can be drawn through the atoms of the crystal. The simpler conception led at once to a simpler procedure. It led to the construction of the X-ray spectrometer, which resembles an ordinary spectrometer in general form, except that the grating or prism is replaced by a crystal and the

telescope by an ionisation chamber and an electroscope. In use a fine pencil of X-rays is directed upon the crystal which is steadily turned until a reflection leaps out; and the angle of reflection is then measured. If we use different crystals or different faces of the same crystal, but keep the rays the same we can compare the geometrical spacings of the various sets of planes. If we use the same crystal always, but vary the source of X-rays we can analyse the latter, measuring the relative wave-lengths of the various constituents of the radiation.

We have thus acquired a double power :—

(1) We can compare the intervals of spacing of the atoms of a crystal or of different crystals, along various directions within the crystal; in this way we can arrive at the structure of the crystal.

(2) We can analyse the radiation of an X-ray bulb; in fact, we are in the same position as we should have been in respect to light if our only means of analysing light had been by the use of coloured glasses, and we had then been presented with a spectrometer, or some other means of measuring wave-length exactly.

We now come to a critical point. If we knew the exact spacings of the planes of some one crystal we could now by comparison find the spacings of all other crystals and measure the wave-lengths of all X-radiations. Or if we knew the exact value of some one wave-length we could find by comparison the values of all other wave-lengths, and determine the spacings of all crystals. But as yet we have no absolute value either of wave-length or of spacings.

The difficulty appears to have been overcome by W. L. Bragg's comparison of the reflection effects in the case of rock-salt or sodium chloride and sylvine or potassium chloride. These two crystals are known to be "isomorphous"; they must possess similar arrangements of atoms. Yet they display a striking difference both in the Laue photograph and on the spectrometer. The reflections from the various series of planes of the latter crystal show spacings consonant with an arrangement in the simplest cubical array. The smallest element of pattern is a cube at each corner of which is placed the same group, a single atom or molecule or group of atoms or molecules. In the case of rock salt, the indications are that the crystal possesses a structure intermediate between the very simple arrangement just described and one in which the smallest element is a cube having a similar group of atoms or molecules at every corner and at the middle point of each face. The arrangement is called by crystallographers the face-centred cube. The substitution of the sodium for the potassium atom must transform one arrangement into the other.

This can be done in the following way, if we accept various indications that atoms of equal weight are to be treated as equivalent. Imagine an elementary cube of the crystal pattern to have an atom of chlorine at every corner and in the middle of each face, and an atom of sodium or potassium as the case may be, at the middle point of each edge and at the centre of the cube. We have now an arrangement which fits the facts exactly. The weights of the potassium and chlorine atoms are so nearly the same as to be practically equivalent, and when they are considered to be so, the arrangement becomes the simple cube of sylvine. But when the lighter sodium replaces the potassium, as in rock-salt, the arrangement is on its way to be that of the face-centred cube, and would actually become so were the weight of the sodium atoms negligible in comparison with those of chlorine.

Of course, the same result would follow were two or three or any number of atoms of each sort to take the place of the single atom, provided the same increase was made in the number of the atoms of both sorts. We might even imagine two sorts of groups of chlorine and metal atoms, one containing a preponderance of the former, the other of the latter, but so that two groups one of each kind contained between them the same proportion of chlorine and metal as the crystal does. We must merely have two groups which differ in weight in the case of rock-salt and are approximately equal in weight in the case of sylvine. But it was best to take the simplest supposition at the outset; and now the evidence that the right arrangement has been chosen is growing as fresh crystals are measured. For it turns out that in all crystals so far investigated, the number of atoms at each point must always be the same. Why, then, should it be more than one? Or, in other words, if atoms are always found in groups of a certain number, ought not that group to be called the atom?

So soon as the structure of a crystal has been found we can at once find by simple arithmetic the scale on which it is built. For we know from other sources the weight of individual atoms, and we know the total weight of the atoms in a cubic centimetre of the crystal. In this way we find that the nearest distance between two atoms in rock-salt is $2{\cdot}81\times10^{-8}$ cm., which distance is also the spacing of the planes parallel to a cube face.

From a knowledge of this quantity the length of any X-ray wave can be calculated at once so soon as the angle of its reflection by the cube face has been measured. In other words, the spectrometer has now become a means of measuring the length of waves of any X-radiation and the actual spacings of the atoms of any crystal.

From this point the work branches out in several directions. It will not be possible to give more than one or two illustrations of the progress along each branch.

Let us first take up the most interesting and important question of the "characteristic" X-rays. It is known that every substance when bombarded by electrons of sufficiently high velocity emits X-rays of a quality characteristic of the substance. The interest of this comparison lies in the fact that it displays the most fundamental properties of the atom. The rays which each atom emits are characteristic of its very innermost structure. The physical conditions of the atoms of a substance and their chemical associations are largely matters of the exterior; but the X-rays come from the interior of the atom and give us information of an intimate kind. What we find is marked by all the simplicity we should expect to be associated with something so fundamental.

All the substances of atomic weight between about 30 and 120 give two strongly defined "lines"; that is to say, there are found among the general heterogeneous radiation two intense, almost homogeneous, sets of waves. For instance, rhodium gives two pencils of wave-lengths approximately equal to $0{\cdot}61\times10^{-8}$ cm. and $0{\cdot}54\times10^{-8}$ cm. respectively. More exactly the former of these is a close doubtlet having wave-lengths $0{\cdot}619\times10^{-8}$ and $0{\cdot}614\times10^{-8}$. The wave-lengths of palladium are nearly $0{\cdot}58\times10^{-8}$ and $0{\cdot}51\times10^{-8}$; nickel, $1{\cdot}66\times10^{-8}$ and $1{\cdot}50\times10^{-8}$. Lately Moseley has made a comparative study of the spectra of the great majority of the known elements, and has shown that the two-line spectrum is characteristic of all the substances the atomic weights of which range from that of aluminum, 27, to that of silver, 108. These X-rays constitute, there is no doubt whatever, the characteristic rays which Barkla long ago showed to be emitted by this series of substances.

Now comes a very interesting point. When Moseley sets the increasing atomic weights against the correspondingly decreasing wave-lengths, the changes do not run exactly parallel with each other. But if the wave-lengths are compared with a series of natural numbers everything runs smoothly. In fact, it is obvious that the steady decrease in the wave-length as we pass from atom to atom of the series in the periodic table implies that some fundamental element of atomic structure is altering by equal steps. There is excellent reason to believe that the change consists in successive additions of the unit electric charge to the nucleus of the atom. We are led to think of the magnitude of the nucleus of any element as being simply proportional to the number indicating the place of the element in the periodic table, hydrogen having a nuclear charge of one unit, helium two, and so on. The atomic weights of the successive elements do not increase in an orderly way; they mount by steps of about two, but not very regularly, and sometimes they seem absolutely to get into the wrong order. For example, nickel has an atomic weight of 58·7, whereas certain chemical properties, and, still more, its behaviour in experiments on radio-activity indicate that it should lie between cobalt (59) and copper (63·6). But the wave-lengths, which are now our means of comparison, diminish with absolute steadiness in the order cobalt, nickel, copper. Plainly, the atomic number is a more fundamental index of quality than the atomic weight.

It is very interesting to find, in the series arranged in this way, three, and only three, gaps which remain to be filled by elements yet undiscovered.

Let us now glance at another and most important side of the recent work, the determination of crystalline structure. We have already referred to the case of the rock-salt series, but we may look at it a little more closely in order to show the procedure of crystal analysis.

The reflection of a pencil of homogeneous rays by a set of crystalline planes occurs, as already said, at a series of angles regularly increasing, giving, as we say, spectra of the first, second, third orders, and so on. When the planes are all exactly alike, and equally spaced, the intensities of the spectra decrease rapidly as we proceed to higher orders, according to a law not yet fully explained. This is, for example, the case with the three most important sets of planes of sylvine, those perpendicular to the cube edge, the face diagonal and the cube diagonal respectively. An examination of the arrangement of the atoms in the simple cubical array of sylvine shows that for all these sets the planes are evenly spaced and similar to each other. It is to be remembered that the potassium atom and the chlorine atom are so nearly equal in weight that they may be considered effectively equal. In the case of rock-salt the same may be said of the first two sets of planes, but not of the third. The planes perpendicular to the cube diagonal are all equally spaced, but they are not all of equal effect. They contain alternately, chlorine atoms (atomic weight 35·5) only, and sodium atoms (atomic weight 23) only. The effect of this irregularity on the intensities of the spectra of different orders is to enhance the second, fourth, and so on in comparison with the first, third, and fifth. The analogous effect in the case of light is given by a grating in which the lines are alternately light and heavy. A grating specially ruled for us at the National Physical Laboratory shows this effect very well. This difference between rock-salt and sylvine and its explanation in this way constituted an important link in W. L. Bragg's argument as to their structure.

When, therefore, we are observing the reflections in the different faces of a crystal in order to obtain data for the determination of its structure, we have more than the values of the angles of reflection to help us; we have also variations of the relative intensities of the spectra. In the case just described we have an example of the effect produced by want of similarity between the planes, which are, however, uniformly spaced.

In the diamond, on the other hand, we have an example of an effect due to a peculiar arrangement of planes which are otherwise similar. The diamond crystallises in the form of a tetrahedron. When any of the four faces of such a figure are used to reflect X-rays, it is found that the second order spectrum is missing. The analogous optical effect can be obtained by ruling a grating so that, as compared with a regular grating of the usual kind, the first and second, fifth and sixth, ninth and tenth, alone are drawn. To put it another way, two are drawn, two left out, two drawn, two left out, and so on. The National Physical Laboratory has ruled a special grating of this kind also for us, and the effect is obvious. The corresponding inference in the case of the diamond is that the planes parallel to any tetrahedral face are spaced in the same way as the lines of the grating. Every plane is three times as far from its neighbour on one side as from its neighbour on the other. There is only one way to arrange the carbon atoms of the crystal so that this may be true. Every atom is at the centre of a regular tetrahedron composed of its four nearest neighbours, an arrangement best realised by the aid of a model. It is a beautifully simple and uniform arrangement, and it is no matter of surprise that the symmetry of the diamond is of so high an order. Perhaps we may see also in the perfect symmetry and consequent effectiveness of the forces which bind each atom to its place an explanation of the hardness of the crystal.

Here, then, we have an example of the way in which peculiarities of spacing can be detected. There are other crystals in which want of uniformity, both in the spacings and in the effective values of the planes, combine to give cases still more complicated. Of these are iron pyrites, calcite, quartz, and many others. It would take too long to explain in detail the method by which the structures of a large number of crystals have already been determined. Yet the work done so far is only a fragment of the whole, and it will take no doubt many years, even though our methods improve as we go on, before the structures of the most complicated crystals are satisfactorily determined.

On this side then we see the beginning of a new crystallography which, though it draws freely on the knowledge of the old, yet builds on a firmer foundation since it concerns itself with the actual arrangement of the atoms rather than the outward form of the crystal itself. We can compare with the internal arrangements we have now discovered the external forms which crystals assume in growth, and the modes in which they tend to come apart under the action of solvents and other agents By showing how atoms arrange and disarrange themselves under innumerable variations of circumstances we must gain knowledge of the nature and play of the forces that bind the atoms together.

There is yet a third direction in which inquiry may be made, though as yet we are only at the beginning of it. In the section just considered we have thought of the atoms as at rest. But they are actually in motion, and the position of an atom to which we have referred so frequently must be an average position about which it is in constant movement. Since the atoms are never exactly in their places, the precision of the joint action on which the reflection effect depends

suffers materially. The effect is greater the higher the order of the spectrum. When the crystal under examination is contained within a suitable electric furnace and the atoms vibrate more violently through the rise of temperature, the intensities of all orders diminish, but those of higher order much more than those of lower. The effect was foreseen by the Dutch physicist Debije, and the amount of it was actually calculated by him on certain assumptions. I have found experimental results in general accord with his formula. In passing, it may be mentioned that as the crystal expands with rise of temperature the spacing between the planes increases and the angles of reflection diminish, an effect readily observed in practice.

This part of the work gives information respecting the movements of the atoms from their places, the preceding respecting their average positions. It is sure, like the other, to be of much assistance in the inquiry as to atomic and molecular forces, and as to the degree to which thermal energy is locked up in the atomic motions.

This brief sketch of the progress of the new science in certain directions is all that is possible in the short time of a single lecture; but it may serve to give some idea of its fascination and its possibilities.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

BIRMINGHAM.—The death of the Chancellor of the University, the Righ Hon. Joseph Chamberlain, cast a gloom over the annual Degree Congregation, and the festivities which had been arranged in connection therewith were all abandoned.

Mrs. Poynting has presented the scientific library of the late Prof. J. H. Poynting to the physics department of the University. The gift is a valuable one in itself and in its associations, and the spirit in which it is given is highly appreciated.

The opposition of the University to the proposal of the City Council to run a tram line past the front of Mason College has resulted in a compromise whereby the line is not to be used for the conveyance of passengers, and cars are only to be run along it during vacations or before 9.30 a.m. or after 6 p.m. on ordinary days, or on occasions of special pressure or emergency to be mutually agreed upon.

Dr. J. S. Anderson has been appointed assistant lecturer and demonstrator in physics for one year in succession to Dr. Fournier d'Albe. Mr. W. Hulse has been appointed demonstrator in mining in succession to Mr. Clubb. Mr. Gilbert Johnson has been appointed a member of the staff of the agricultural research section of the zoological department.

The degree of D.Sc. has been conferred on H. B. Keene and F. W. Aston, and the degree of M.D. on E. W. Assinder and O. M. Holden. The official degree of M.Sc. has been conferred on Prof. F. C. Lea and that of M.Com. on G. H. Morley, who has been secretary of Mason College and of the University since its foundation.

THE University of Liverpool has conferred on Mr. T. F. Wall, D.Sc., the degree of Doctor of Engineering.

PROF. D. T. GWYNNE-VAUGHAN, professor of botany in the Queen's University, Belfast, has been appointed to the chair of botany at University College, Reading, vacant by the resignation of Prof. F. W. Keeble, who has been appointed director of the experiment station and gardens of the Royal Horticultural Society at Wisley.

WE learn from *Science* that with the close of the present term at the Massachusetts Institute of Technonology, Prof. R. H. Richards will retire from the active work of teaching which he has followed for forty-six years. He has been made professor emeritus and receives the benefits of the Carnegie Foundation. Prof. Richards has been identified with the institute since its beginning. In 1871 he was appointed to the chair of mineralogy in the department that afterwards developed into that of mining, engineering, and metallurgy.

THE first Aitchison Memorial Scholarship is to be awarded next September. The scholarship was established by his friends and colleagues as a memorial of the late Mr. James Aitchison. Its value is 30*l.*, and it is tenable in the full-time day courses in technical optics at the Northampton Polytechnic Institute. Applications must be received by September 1 by Mr. Henry F. Purser, 35 Charles Street, Hatton Garden, London, E.C., from whom full particulars can be obtained.

IT is announced in the issue of *Science* for June 26 that at the celebration of the centenary of the foundation of the Yale University Medical School, large gifts were announced in addition to the 100,000*l.* from the General Education Board of the United States. These donations included a provisional gift of 100,000*l.* for the Anthony N. Brady foundation, and 120,000*l.* from donors not officially named. Our contemporary also states that by the will of the late Mr. James Campbell, the St. Louis University Medical School will receive his entire estate after the death of his heirs, who have a life interest in it. The present value of the estate is estimated to be from three to eight millions sterling. Also that by the will of the late Mr. Thomas W. Holmes, of Troy, Rensselaer Polytechnic Institute is bequeathed the sum of 10,000*l.* From the same source we learn that Miss Susan Minns has given 10,000*l.* to the department of botany of Wellesley College, in memory of Susan M. Hallowell, the former head of the department.

SOCIETIES AND ACADEMIES.

LONDON.

Linnean Society, June 18.—Prof. E. B. Poulton, president, in the chair.—R. D. **Laurie**: Reports on the marine biology of the Sudanese Red Sea.—On the Brachyura.—G. **Matthai**: A revision of the recent Colonial Astræidæ possessing distinct corallites.—C. F. M. **Swynnerton**: Short cuts to nectaries by blue tits. The author referred to his previous account of African ornithophilous flowers, read on March 5 last, and showing photographs of injured shoots of Ribes on the screen.—W. **West**: Ecological notes, chiefly cryptogamic. This paper was the outcome of a suggestion by Prof. Engler, that whilst abundance of observations existed of ecological facts regarding phanerogams, the cryptogams had been neglected. It was intended as the first of a series, which has been cut short by the death of the author. The observations extend over parts of Scotland, Wales, Ireland, and the Lake District.—R. J. **Tillyard**: Life-histories and descriptions of Australian Æschninæ, with a description of a new form of Telephebia by Herbert **Campion**.—Miss Olga G. M. **Payne**: The life-history and structure of *Telephorus lituratus*.—A. **Grouvelle**: Cucujidæ, Cryptophagidæ, avec une description de la larve et de la nymphe de *Protominia convexiuscula*, Grouvelle.—H. **Scott**: Mallophaga, Aphaniptera, and Diptera Puparia.

Challenger Society, June 24.—Dr. A. E. Shipley in the chair.—Commander Campbell **Hepworth**: The origin of the Gulf weed. Commander Hepworth initiated a discussion by referring to a form of Sargassum found in the central part of the Sargasso Sea. Seed-like bodies were stated to have been seen from which small leaves sprouted in various stages of growth up to 4 or 5 in. long. It was suggested that these might represent a mode of reproduction not hitherto recognised in Sargassum.—G. C. **Robson**: Lo Bianco's work on the periods of sexual activity in marine animals. The lists compiled by Lo Bianco from observations over a period of thirty years on the animals of the Gulf of Naples were analysed, and an attempt was made to discover causes for the differences of breeding period in various species, genera, and larger groups. It was concluded that while in certain cases it seemed possible to correlate these differences with the mode of life of the animals, in other cases the differences appeared to be non-adaptive.

PARIS.

Academy of Sciences, June 29.—M. P. Appell in the chair.—G. **Bigourdan**: The various classifications of nebulæ and star clusters and the abbreviations employed for describing these objects. A historical account of the systems of classification and the corresponding abbreviations due to J. Herschel, Schultz, Kobold and Wirtz, Wolf, S. I. Bailey, Stone, and Merecki. The author proposes a system partially based on these, and gives a list of the principal abbreviations which he suggests might be universally adopted.—J. **Meyeringh** and A. **Haller**: Dimethylallylacetophenone and its oxidation products. Careful oxidation with weak alkaline permanganate gave the glycol,

$$C_6H_5.CO.C(CH_3)_2CH_2.CH(OH).CH_2.OH,$$

or 2-benzoyl-2-methyl-4 : 5-pentanediol. The reactions of this glycol with benzoyl chloride and phenyl isocyanate have been studied, and the products are described.—André **Blondel**: Analysis of the induction reactions in alternators.—C. **Guichard**: Surfaces such that the osculating spheres to the lines of curvature of a series form an O or a 2I system.—Georges **Charpy**: The influence of time on the rapid deformations of metals. In testing metals by shock, the variation of the time of deformation was varied from 0·01 to 0·001 second, and this variation produced no practical differences in the work absorbed by the breaking.—H. **Parenty**: An experimental law for the flow of gases and steam through orifices.—F. W. **Dyson** was elected a correspondant for the section of astronomy, in the place of the late Sir David Gill.—A. **Buhl**: The normal curvature of closed contours.—R. J. **Backlund**: The zeros of the function $\zeta(s)$ of Riemann.—Theodor **Poeschl**: An evaluation of potentials.—Leonida **Tonelli**: A direct method for the calculus of variations.—Harald **Bohr**: The function $\zeta(s)$ of Riemann.—André **Léauté**: The problem of two electric lines branched in series.—A. **Schidlof** and A. **Karpowicz**: The evaporation of globules of mercury maintained in suspension in a gaseous medium. It was found in experiments designed to measure the elementary charge on fine mercury particles in suspension that the velocity of fall diminished continuously, an effect possibly due to evaporation. This phenomenon would vitiate the conclusions drawn by Ehrenhaft from his experiments.—Mlle. Paule **Collet**: The variations of resistance of crystals and residual electromotive forces.—J. **Minguin** and R. **Bloc**: The influence of solvents on the optical activity of the ortho- and allo-acid methyl camphorates and the neutral camphorate. The solvent exerts a very considerable influence on the optical activity. Thus the ortho-methyl camphorate in formic acid gave $\alpha = 8{\cdot}16°$, in cinnamene, $\alpha = 13{\cdot}46°$, numerous other organic solvents giving intermediate values.—M. **Leprince-Ringuet**: The inflammability of mixtures of methane and various gases.—F. **Ducelliez** and A. **Raynaud**: The bromination of cobalt and nickel in presence of ethyl ether. The compounds, $CoBr_2(C_4H_{10}O)$ and $NiBr_2(C_4H_{10}O)$, are produced. These are decomposed by heat and give the anhydrous bromides.—O. **Hönigschmid**: Revision of the atomic weight of uranium. Analyses of the bromide gave 238·175 as the mean value of fourteen determinations.—C. **Gaudefroy**: The dehydration of gypsum. The transformation of the hemihydrate into the soluble anhydride is reversible. This accounts for the different temperatures given by various observers as that at which the anhydrous calcium sulphate is produced the temperature depends on the hygrometric state of the air in the oven.—E. **Gley**: The function of the suprarenal capsules in the action of vaso-constrictive substances. Indirect vaso-constrictive substances.—J. **Chaine**: A fairly frequent error of interpretation in comparative anatomy.—A. **Vayssière** and G. **Quintaret**: A case of hermaphrodism in *Scyllium stellare*.—Maurice **Caullery**: The Siboglinideæ, a new type of invertebrates collected by the Siboga expedition.—MM. **Bonnefon** and **Lacoste**: Experimental researches on the grafting of the cornea.—H. **Busquet** and M. **Tiffeneau**: The rhythmic oscillations of the tonicity of the ventricles on the isolated rabbit's heart.—T. **Bézier**: The existence of a Carboniferous flora, possibly Westphalian, at Melesse (Ille-et-Vilaine).—R. **Tronquoy**: Some new data concerning the geology and petrography of the Congo.—Jacques **Deprat**: The Palæozoic strata and the Trias in the region of Hoa-Binh and of Cho-Bo (Tonkin).—J. **Giraud**: The sedimentary strata of the south and west of Madagascar.—Maurice **Lugeon**: The extent of the Morcles strata.—Jean **Chautard**: Contribution to the study of the origin of petroleum.—Pereira de **Sousa**: The effects in Portugal of the earthquake of November 1, 1755. The results of the study of a document by the Marquis de Pombal, recently discovered in the national archives of Lisbon.

CAPE TOWN.

Royal Society of South Africa, May 20.—The president in the chair.—T. **Muir**: Properties of Pfaffians and their analogues in determinants.—J. C. **Beattie**: The secular variation of the magnetic elements in South Africa during the period 1900–13. The annual changes in the magnetic declination vary from an average decrease of 1·5′ of westerly declination at Mauritius during 1900–9—a change which has turned into an increase of 1·4′ a year between 1907–9—to a decrease of 14′ a year in the neighbourhood of Durban; from the latter place the decrease becomes less as we go in a north-westerly direction, and attains a value of 5′ at Loanda; the decrease as we go west or south-west is also quite definite, though not so great, and at Cape Town has the value of 8′. It appears also that the absolute value of the decrease is increasing all over South Africa at the present time. A comparison of the results given in the paper with those of the American and British Admiralty declination charts for approximately the same epoch shows no continuity between the land values of the secular change and those over the sea, the high values over the land find no place over the sea except in the case of the result obtained from the *Gauss* and *Carnegie* observations. The greatest annual change of dip is found in the

south-western part of the continent in the neighbourhood of Cape Town; it amounts to an increase of southerly dip of 8′ a year. The line of no change passes through Madagascar; east of that there is a decrease of southerly dip. The annual change in the horizontal intensity shows a decrease in absolute magnitude towards the north; over the greater part of the Union it has a value of from 80 γ to 100 γ yearly, and is a decrease.

BOOKS RECEIVED.

Historical Sketches of Old Charing. By Dr. J. Galloway. Pp. 82. (London: John Bale, Ltd.) 10*s*. 6*d*. net.

Le Musée d'Histoire Naturelle Moderne. Sa Mission, son Organisation, ses Droits. By G. Gilson. Pp. xii+256. (Bruxelles: Académie Royale.)

A First Course in Plant and Animal Biology. By W. S. Furneaux. Pp. viii+232. (London: University Tutorial Press, Ltd.) 2*s*.

Die Europaeischen Schlangen. By Dr. F. Steinheil. Sechstes Heft. Tafel 26–30. (Jena: G. Fischer.) 3 marks.

Handbuch der Pharmakognosie. By A. Tschirch. Lief. 35, 36, 37. (Leipzig: C. H. Tauchnitz.) 2 marks each Lief.

Berliner Botaniker in der Geschichte der Pflanzenphysiologie. By G. Haberlandt. Pp. 29. (Berlin: Gebrüder Borntraeger.) 1 mark.

Grundzüge der Weltpolitik in der Gegenwart. By J. J. Ruedorffer. Pp. xiii+252. (Stuttgart and Berlin: Deutsche Verlags-Anstalt.)

Principles of Metallurgy. By A. H. Hiorns. Second edition. Pp. xiv+389. (London: Macmillan and Co., Ltd.) 6*s*.

The Continents and their People. Africa. By J. F. and A. H. Chamberlain. Pp. vii+210. (London: Macmillan and Co., Ltd.) 3*s*.

Every Child's Series. How Man Conquered Nature. By M. J. Reynolds. Pp. v+249. (London: Macmillan and Co., Ltd.) 1*s*. 8*d*. net.

The Happy Golfer. By H. Leach. Pp. vii+414. (London: Macmillan and Co., Ltd.) 6*s*. net.

The School Algebra. By A. G. Cracknell. Pp. viii+568+lxxvii. (London: University Tutorial Press, Ltd.) 5*s*.

Pond Problems. By E. E. Unwin. Pp. xvi+119. (Cambridge University Press.) 2*s*. net.

Handbuch der Morphologie. Edited by A. Lang. Vierter Band. Arthropoda. Vierte Lief. Pp. 421–640. (Jena: G. Fischer.) 5 marks.

Roberts-Austen: a Record of his Work. Compiled and edited by S. W. Smith. Pp. x+382+xxiii plates. (London: C. Griffin and Co., Ltd.) 21*s*. net.

Historical Account of Charing Cross Hospital and Medical School. By Dr. W. Hunter. Pp. xxi+309+xl plates. (London: J. Murray.) 21*s*.

County Borough of Halifax. Bankfield Museum Notes. Second series. No. 4. Coptic Cloths. By L. E. Start. Pp. 37. (Halifax: King and Sons.) 2*s*. 6*d*.

Memoirs of the Geological Survey. England and Wales. The Water Supply of Nottinghamshire from Underground Sources. By G. W. Lamplugh and B. Smith. Pp. iv+174. (London: H. M. Stationery Office.) 5*s*.

Memoirs of the Geological Survey. Summary of Progress of the Geological Survey of Great Britain and the Museum of Practical Geology for 1913. Pp. iv+107. (London: H.M. Stationery Office.) 1*s*.

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