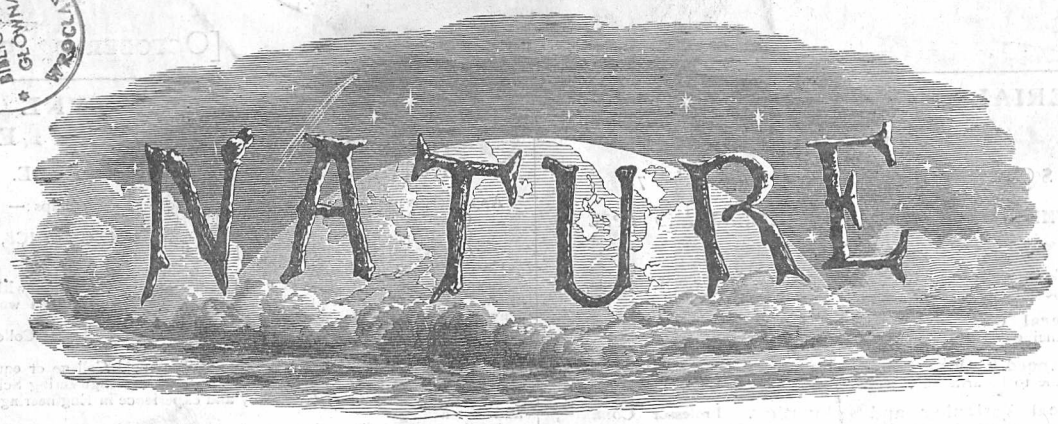

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

INDEX NUMBER.

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IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY.

SOUTH KENSINGTON, S.W. 7.

DEPARTMENT OF OPTICAL ENGINEERING AND APPLIED OPTICS.

The following Courses of Weekly Lectures will commence during the Autumn Session, 1919:—

1. **General Optics (Elementary)** Professor CHESHIRE. Commencing Wednesday, October 15, at 2.30 p.m.
2. **Advanced Optics.** Professor CHESHIRE and Mr. L. C. MARTIN. Time to be arranged.
3. **Optical Designing and Computing.** Professor CONRADY, Commencing Monday, October 20, at 3.0 p.m.
4. **Advanced Designing and Computing.** Professor CONRADY, Commencing Tuesday, October 14, at 3.0 p.m.
5. **Workshop and Testing Room Methods, and Properties of Glass.** Professor CONRADY. Commencing Wednesday, October 15, at 2.30 p.m.
6. **Construction, Theory, and Use of Optical Measuring Instruments.** Mr. L. C. MARTIN. Commencing Friday, October 17, at 2.30 p.m.

Laboratory or Class Work is arranged in conjunction with all the above Courses.

The following Special Courses of Lectures will also be given:

Polarized Light and Polarization Apparatus (6 Lectures). Professor CHESHIRE. Commencing Tuesday, October 21, at 4 p.m. Fee 5*s*.

Microscopes and Microscopic Vision (10 Lectures). Professor CONRADY. Commencing Wednesday, October 15, at 5 p.m. Fee 5*s*.

Theory of the Aberrations of Lens Systems (10 Lectures). Mr. S. D. CHALMERS, M.A. Commencing Wednesday, October 15, at 12 noon. Fee 5*s*.

For further particulars and for admission tickets apply to the REGISTRAR at the above address.

The DIRECTOR is open to receive applications from students and others desirous of carrying out Research Work in the Laboratories.

UNIVERSITY OF LONDON.

The following Advanced Lectures will be delivered:—A Course of ten Lectures on "HISTOLOGY OF THE NERVOUS SYSTEM," by Dr. C. D. da Fano, at King's College, Strand, W.C.2, on Tuesdays, commencing on October 7, at 4.30 p.m.

A Course of Lectures on "THE ENERGY BALANCE OF THE HUMAN BODY." "ELECTRICAL SIGNS OF EMOTIVE PHENOMENA," by Prof. A. D. Waller, M.D., F.R.S., at the Imperial College of Science and Technology, South Kensington, S.W.7, on Wednesdays, commencing on October 15, at 5 p.m. Admission free, without ticket.

P. J. HARTOG,
Academic Registrar.

ARMSTRONG COLLEGE, NEWCASTLE-UPON-TYNE.

PROFESSORSHIP OF ENGINEERING.

The Council invites applications for this PROFESSORSHIP, now vacant owing to the retirement of Professor Weighton. Candidates should be men of high attainments both in an educational and in a professional sense, and must have special qualifications and experience in Marine Engineering. Age not to exceed 45 years. Salary will commence at £1,250 per annum. Ten copies of applications and of not more than three testimonials must be sent so as to reach the REGISTRAR, Armstrong College, *not later than October 21*, 1919.

BOROUGH POLYTECHNIC INSTITUTE,

BOROUGH ROAD, LONDON, S.E.1.

Applications are invited by the Governors for the post of LECTURER in the ELECTROTECHNICS Department (Day Technical School and Evening Class Department). Candidates should have had some teaching experience and must possess a University degree or its equivalent, but this latter disqualification will not be insisted upon in the case of persons otherwise exceptionally qualified.

The commencing salary will be £300 per annum, rising by annual increments to £400. Particulars and forms of application may be obtained by sending stamped addressed envelope.

Applications should be received as soon as possible, but not later than October 13, 1919.

C. T. MILLIS, Principal.

NEWCASTLE-UPON-TYNE EDUCATION COMMITTEE.

RUTHERFORD TECHNICAL COLLEGE.

Applications are invited for the undermentioned Lectureships:—
(*a*) MATHEMATICS and PHYSICS,
(*b*) PRACTICAL MATHEMATICS and MECHANICS,
(*c*) ENGINEERING SUBJECTS.

Candidates should have the following qualifications—

In the case of (*a*), a University or Technical College education with a University Degree or its equivalent, practical experience in the work of a Physics Laboratory and teaching experience.

In the case of (*b*), good training in a University or Technical College and some experience of teaching.

In the case of (*c*), good training in a Technical College or equivalent Institution in Theoretical and Laboratory Work in Engineering Science, a Diploma or Certificate of Proficiency and experience in Engineering Works and of teaching.

Applications, *stating salary required*, to be made to the undermentioned not later than October 18, 1919. Forms may be obtained upon receipt of a stamped addressed foolscap envelope.

THOS. WALLING,
Education Office, Acting Director of Education.
Northumberland Road, Newcastle.

SOUTH AFRICAN SCHOOL OF MINES AND TECHNOLOGY, JOHANNESBURG

(UNIVERSITY OF SOUTH AFRICA).

The Council invite applications for the following appointment: A LECTURER FOR THE DEPARTMENT OF ELECTROTECHNICS. Salary £450 per annum, rising by annual increments of £25 to a maximum of £550. The appointment will, in the first instance, be probationary for two years, according to the Regulations of the Union Education Department. £40 will be allowed for travelling expenses to Johannesburg, and half salary from date of sailing to arrival. Members of staff have to supervise and take part in evening work. The selected candidate will be required to pass medical examination before appointment. He will be required to take up his duties in Johannesburg about February 15, 1920. Applications in triplicate, stating age, professional qualifications and experience, with copies of three recent testimonials, should be sent not later than October 20 to the undersigned, who will supply further particulars if desired.

CHALMERS, GUTHRIE & CO., LIMITED,
9 Idol Lane, London, E.C. 3.

SWANSEA EDUCATION COMMITTEE.

HIGH SCHOOL FOR GIRLS.

Headmistress:—Miss E. K. MULLINS (Cantab.).

Wanted, a SENIOR HISTORY MISTRESS to take up duties in January.

Applicants must hold a good Honours Degree or its equivalent.

Salary £240 per annum, rising by £10 annually to a maximum of £360.

Application Forms may be obtained from me on receipt of a stamped addressed envelope.

Education Offices, T. J. REES,
Dynevor Place, Swansea. Director of Education.
October 6, 1919.

ESSEX EDUCATION COMMITTEE.

EAST ANGLIAN INSTITUTE OF AGRICULTURE.

LECTURER IN AGRICULTURE.

Wanted, a LECTURER in AGRICULTURE to conduct local Winter Schools in Agriculture, lecture to Institute Students on Agricultural Book-keeping and Field Surveying, and assist in the supervision of Field Experiments.

Salary £350 by annual increments of £20 to £450.

Application forms obtainable from the undersigned, must be returned accompanied by three testimonials by October 23.

East Anglian Institute of Agriculture, R. M. WILSON,
Chelmsford. Principal.

TEACHERS' REGISTRATION COUNCIL.

Representative of the Teaching Profession.
(Constituted by Order in Council, February 29, 1912.)
IN ACCORDANCE WITH THE ABOVE ORDER
A
REGISTER OF TEACHERS
IS NOW MAINTAINED BY THE COUNCIL.
For information apply to:—
The SECRETARY, Teachers' Registration Council, 47 Bedford Square, London, W.C. 1.

For other Official Advertisements see pages lxiv *and* lxv.

UNIVERSITY COLLEGE OF WALES, ABERYSTWYTH

(a Constituent College of the University of Wales).

The Council will shortly proceed to elect to the Office of PRINCIPAL Salary £1,500 per annum. A knowledge of Welsh will be regarded as essential. The Principal will hold periodically the Office of Vice-Chancellor of the University of Wales.

Any further particulars required may be obtained from the undersigned.

Applications for the post must be forwarded to him not later than October 15, 1919.

The Council does not necessarily limit itself in its choice to names sent in in response to this advertisement.

J. H. DAVIES, Registrar.

THE TECHNICAL COLLEGE, LOUGHBOROUGH.

H. SCHOFIELD, M.B.E., B.Sc. (Hons.) Lond., A.R.C.Sc. (Lond.), A.M.I.C.E., Principal.

Wanted immediately, a full-time ASSISTANT in the DEPARTMENT of CHEMICAL TECHNOLOGY.

A knowledge of Physics is considered essential.

Salary £250 per annum, rising by annual increments of £25 to £350 per annum.

Full particulars may be obtained from the PRINCIPAL, to whom all applications should be addressed, not later than October 25, 1919.

W. A. BROCKINGTON,
Director of Education.

EDINBURGH & EAST OF SCOTLAND COLLEGE OF AGRICULTURE.

CHEMISTRY DEPARTMENT.

Applications are invited for the post of SENIOR ASSISTANT LECTURER in the Chemistry Department.

Salary (including Bonus) £360.

Further particulars may be obtained from the undersigned, to whom application should be made.

ALEXANDER LAUDER,
Director of Studies.

KENT EDUCATION COMMITTEE.

COURSE FOR RURAL TEACHERS.

The Committee require the services of a LECTURER, on alternate Saturdays, for 20 lectures in Rural History for Teachers, to be held at Ashford, beginning some time in October. Salary according to qualifications and experience. Applications should be sent as soon as possible to the undersigned.

E. SALTER DAVIES,
Director of Education.

Sessions House,
Maidstone, Kent.

UNIVERSITY OF BIRMINGHAM.

ASSISTANT LECTURER AND DEMONSTRATOR IN CHEMISTRY.

The Council invites applications for the above post. Stipend £250 per annum.

Applications, accompanied by testimonials, should be sent to the undersigned not later than Saturday, October 11, 1919. No special form of application is required.

It is hoped that the Candidate elected will be able to enter upon his duties forthwith.

Further particulars may be obtained from

GEO. H. MORLEY, Secretary.

UNIVERSITY OF NEW ZEALAND. VICTORIA UNIVERSITY COLLEGE, WELLINGTON, NEW ZEALAND.

Applications are invited for PROFESSORSHIP of MODERN LANGUAGES at the above University, at a salary of £700 per annum. Duties to commence March 15, 1920. Full particulars and forms of application obtainable by sending stamped addressed foolscap envelope to the HIGH COMMISSIONER FOR NEW ZEALAND, 415 Strand, London, W.C 2, by whom applications will be received up to November 1 next.

SCHOOL OF METALLIFEROUS MINING (CORNWALL).

Applications are invited for the post of PRINCIPAL of the above School.

Candidates should possess special qualifications in Science as applied to Mining and Metallurgy, and preference will be given to candidates who have had practical experience in Mining and (or) Metallurgy.

Commencing salary £600 to £750 according to qualifications.

Applications accompanied by testimonials should be sent to the SECRETARY, School of Metalliferous Mining, Camborne not later than October 18, 1919.

WANTED.

DEMONSTRATORS for the PHYSICS LABORATORY, UNIVERSITY OF EDINBURGH. Excellent opportunities for Research. Salary £200 per annum. Write, giving age and qualifications.

RESEARCH ASSISTANTS. Write, giving experience of general laboratory work, glass blowing, instrument making (not all essential). State salary required. Particulars of duties given on application.

INSTRUMENT MAKER for Physics Laboratory. Write, stating age, experience, and salary required.

All enquiries and applications to be sent to Professor BARKLA, University of Edinburgh.

ROYAL TECHNICAL INSTITUTE, SALFORD.

Principal:—B. PRENTICE, D.Sc., Ph.D.

WANTED: TEMPORARY ASSISTANT LECTURER in ARCHITECTURAL DRAWING (structural steelwork experience desirable). Salary according to qualifications and experience. Forms of application, which should be returned not later than October 28, may be obtained from the SECRETARY, Education Office, Chapel Street, Salford.

L. C. EVANS, Town Clerk.

LEICESTERSHIRE EDUCATION COMMITTEE.

APPOINTMENT OF ASSISTANT AGRICULTURAL INSTRUCTOR.

Applications are invited for the above-mentioned position. Salary £250 per annum plus travelling allowance. Particulars of duties may be obtained from the undersigned.

6 Millstone Lane,
Leicester.

THOMAS HACKING,
Agricultural Organiser.

TROWBRIDGE HIGH SCHOOL FOR BOYS.

COUNTY SECONDARY SCHOOL.

ASSISTANT MASTER wanted immediately. Junior Science desirable. Salary scale for graduates £160 to £380; for non-graduates £140 to £250.

The initial salary will be increased by £10 for each year of previous Secondary School experience and military service.

Apply to the HEAD MASTER.

BRITISH DYESTUFFS CORPORATION LIMITED.

Applications are again invited from well-trained ORGANIC CHEMISTS for positions in the Research Laboratories of the above Corporation. A sound training in theoretical work and manipulative organic chemistry is essential. Previous research experience desirable.

Apply with full particulars of career, degrees, etc., to the CHEMICAL SECRETARY, British Dyestuffs Corporation Limited, Blackley, Manchester.

UNIVERSITY OF LEEDS.

DEPARTMENT OF MINING.

The University Council will shortly proceed to the appointment of a PROFESSOR of MINING, at a salary of £700 a year. The Professor will have opportunity for private consulting practice. Full particulars may be obtained from the SECRETARY, The University, Leeds, who will receive applications up to October 13.

UNIVERSITY OF ABERDEEN.

DEPARTMENT OF CHEMISTRY.

Two RESEARCHER-ASSISTANTS are about to be appointed in this Department. Persons who desire to have their names considered should send them, along with testimonials, to the SECRETARY of the University before October 6. The salary is £250 per annum.

CLIFTON COLLEGE.

HEAD OF PHYSICS DEPARTMENT.

Wanted: a HEAD of the Physics Department to begin work in January. Salary according to qualifications and experience. Age 30 to 40 preferred.

Apply with testimonials to the HEADMASTER on or before November 8.

UNIVERSITY OF LIVERPOOL.

DEMONSTRATOR IN PHYSICS wanted immediately. Salary £200. Applications to the REGISTRAR.

For other Official Advertisements see pages lxii *and* lxv.

WIGAN AND DISTRICT MINING AND TECHNICAL COLLEGE.

Wanted: a LECTURER in PHYSICS is required. Commencing salary up to £300, according to qualifications and experience.
Increments according to scale, which is at present under revision.
Applications should be forwarded as soon as possible to the PRINCIPAL, from whom further particulars may be obtained.

GUY'S HOSPITAL.

Wanted, Part-time DEMONSTRATOR in CHEMISTRY. £150 per annum. Preference will be given to one who is anxious to undertake research work. Reply to DEAN, Medical School, Guy's Hospital, S.E.1

PHOTOGRAPHIC EMULSION CHEMIST. Bromide, Gaslight, and other papers; thoroughly competent and practical; must be capable of carrying out the entire process.—Write to Box 1527, WILLING'S, 125 Strand, W.C.2.

RESEARCH CHEMIST. Advertiser will be pleased to hear of really first-rate man. No others need apply. Good salary to the right man. State amount required. Contract for several years after probation period.—Box 252, c/o NATURE Office.

GOVERNMENT LABORATORY, TEMPORARY CHEMICAL ASSISTANTS required. Salary £160-£10-£220. War bonus, Men from £92; Women from £72.—Apply with copies of testimonials, GOVERNMENT CHEMIST, Clement's Inn Passage, W.C.2

EMPLOYMENT WANTED.—Zoologist, with many years' experience, home and tropical, seeks employment in College, Museum, or Scientific Library, or in a secretarial capacity, in U.K. or abroad. Address, "R.H." 99 Woodstock Road, Oxford.

EXTRA CAPITAL, FINANCE £1000 to £100,000 offered for trades, industries, manufacturers, well-established businesses, partnerships, investments.—THE OFFICERS PARTNERSHIP GUARDIAN, 53 Victoria Street, S.W.1. Call.

GLASS BLOWERS wanted for Scientific Glass Apparatus (blowpipe work). State experience and salary required.—Box 251, c/o NATURE Office.

BROWNING'S IMPROVED PLATYSCOPIC LENSES. An achromatic combination, producing the definition of a microscope with the portability of a pocket lens. All powers of magnification, ×6, 10, 15, 20, and 30. Price, single lens, 23s. 6d., or combination of any two powers, 43s. 6d.—JOHN BROWNING, 146 Strand, London, W.C.2.

SEIBERT 3 mm. APO OBJECTIVE, Zeiss Prism Rotator, 5 Quartz Eyepieces by Zeiss, Leitz Mechanical Stage, all in perfect condition. Prices on request.—JOHN BROWNING, 146 Strand, London, W.C.2.

ASTRONOMICAL TELESCOPE, by Watson, 3½-in. photovisual object glass by Dallmeyer, 3 eyepieces, 66, 132, 175. Complete. Equipoise stand, 50 guineas.—JOHN BROWNING, 146 Strand, London, W.C. 2.

ZEISS, LEITZ, VOIGTLANDER, REICHERT, SWIFT and WATSON SECOND-HAND MICROSCOPES FOR SALE. Perfect condition. All complete, with objectives, Abbe condenser and iris, etc.—JOHN BROWNING, 146 Strand, London, W.C. 2

ZEISS ABBE CONDENSER and IRIS, with rack centring movement, rack substage, and mirror, complete, in new condition, 5 gns.—JOHN BROWNING, 146 Strand, London, W.C.2

MAHOGANY CABINET FOR MICROSCOPE SLIDES. Second-hand. Will hold about 1700 slides. 15 gns.—JOHN BROWNING, 146 Strand, London, W.C.2.

TO PETROLOGISTS.—Microscope Slides. Set of 120 Thin Sections of Minerals, by Dr. Krantz, Bonn, 15 gns.—JOHN BROWNING, 146 Strand, London, W.C. 2.

MICROTOME by Leitz, good as new, complete, heavy make and all accessories, 25 guineas.—JOHN BROWNING, 146 Strand, London, W.C.2.

LEITZ PETROLOGICAL MICROSCOPE, quite new. Complete with all accessories, 35 guineas.—JOHN BROWNING, 146 Strand, London, W.C.2

PRISM BINOCULARS BY ZEISS, GOERZ, BAUSCH, ROSS, WATSON. List free.—JOHN BROWNING, 146 Strand, London, W.C.2.

THURSDAY, OCTOBER 9, 1919.

MATHEMATICAL TEXT-BOOKS.

(1) *Empirical Formulas.* By Prof. Theodore R. Running. (Mathematical Monographs, No. 19.) Pp. 144. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1917.) Price 7*s.* net.

(2) *Differential and Integral Calculus.* By Dr. H. B. Phillips. *Differential.* Pp. v+162. *Integral.* Pp. v+194. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1916–17.) Price 9*s.* 6*d.* net.

(3) *A First Course in the Calculus.* Part i. *Powers of X.* By Dr. W. P. Milne and G. J. B. Westcott. (Bell's Mathematical Series.) Pp. xx+196. (London: G. Bell and Sons, Ltd., 1918.) Price 3*s.* 6*d.*

(4) *Dynamics. Part II.* By R. C. Fawdry. (Bell's Mathematical Series.) Pp. viii+179–355+vii. (London: G. Bell and Sons, Ltd., 1919.) Price 2*s.* 6*d.*

(5) *Solid Geometry, including the Mensuration of Surfaces and Solids.* By Prof. R. S. Heath. Fourth edition. Pp. iv+123. (London: Rivingtons, 1919.) Price 4*s.*

(1) ONE of the most important activities of the practical, as well as of the theoretical, man of science is the discovery of laws. Given a number of observations, the problem is to correlate them in the form of a single analytical expression. The basis of such discovery is the recognition of a curve as being one the equation of which is known. But, strictly speaking, there is only one curve that is really recognisable, and this is the straight line. A piece of a circle can easily be mistaken for a piece of an ellipse, and a parabola for a catenary; but if a sufficiently long piece of a curve is straight, then the curve can be pronounced to be a straight line. If, then, it is possible to plot the results of observation in such a way that the resulting points lie on a straight line (even if there are some casual, experimental errors and consequent deviations), then we can at once deduce the law.

This fact underlies the major part of Prof. Running's monograph. The author summarises the most useful types of laws that are reducible to straight-line laws by means of simple transformations. He also gives practical rules for deciding whether such a law is correct for the given data and for the determination of the constants. Nineteen laws are discussed, and illustrated by means of numerical examples, whilst curves are drawn to show graphically the types of relations given by these laws.

A twentieth law is the Fourier expansion. Chapters are added on the method of least squares, interpolation, and numerical integration. The result is an eminently useful handbook for the scientific researcher and the practical engineer, and a highly commendable adjunct to the more theoretical study of mathematics.

The pedagogy is, however, somewhat defective. It is difficult to imagine such a book in the hands of a student. The philosophy of the subject is scarcely entered into at all, and in places, where an attempt at justification is made, the result is not satisfactory. Also, one question remains unanswered: How is one to guess which law to try? Is one to try them all one after the other until the right one is reached? And what if none of those given is correct? Information on this and other points is very desirable, but none is offered.

One or two definite criticisms must be made. The different schemes in the chapter on Fourier series are not always consistent, and some are incomplete. No explanation is given of the meaning of "weights" in the method of least squares. In the chapter on interpolation the difference formula is proved only for integral values of the argument, and then applied to fractional values. In addition, there are a few misprints and some evidences of carelessness. The book thoroughly deserves a second edition, in which, it is hoped, these and other faults will be rectified.

(2) This is a very good book on the calculus, written in the old style with which we have been familiarised by writers like Edwards and Williamson. It is very well written and compact in form; the diagrams are good, and the exercises excellent. Particular attention is paid to questions of a practical nature. The student who has worked through this book conscientiously will have a good, if dull, appreciation of the subject and its manipulation. A few of the pages are headed "Unconventional Methods," but the thrill one gets on seeing this only leads to disappointment. There is nothing unconventional in an involute or in a parabola rotating about an axis.

The second part (which is also issued separately) includes the usual chapters on differential equations and the usual box of tricks.

This book, like so many others, gives the student the impression that there is just one particular integral of a linear differential equation in which the right-hand side is a function of the independent variable. It is more useful to inform the student that there are, of course, an infinite number of particular integrals, but that one of them is obtainable most readily and directly.

In Ex. 3, p. 10, of the second part it would have been more reasonable to put a negative sign to indicate the retarding effect of friction.

(3) Dr. Milne and Mr. Westcott have given expression to an important and fundamental principle in mathematical pedagogy—namely, the secondary nature of the manipulative art, and the first-rate importance of the ideas and methods of mathematics. They have recognised that the main part of the essence of the calculus, and even the most important practical applications of its processes, can be taught and learnt without using anything but the simplest of all functional types —namely, x^n and combinations of powers of x. When once the student has learnt to differentiate x^n, he is ready for much of the mysterious dis-

cipline that constitutes the black art of the calculus method. He can do dynamical problems without the aid of confusing formulæ; he can measure the volume of a tree; he can enclose land economically; he can draw tangents and normals; he can find radii of curvature; he can even solve differential equations. The authors, having recognised this fact, have acted upon it boldly and frankly, with the result that they have produced a book of a peculiarly suggestive and persuasive kind. Both authors are experienced teachers of mathematics, and the practical touch introduced by the physical propensities of one of them is everywhere noticeable. It is also refreshing to see $dy/dx=f(x)$ treated as a differential equation.

The merit of the book is somewhat marred by a few faults, and especially by the mediocre diagrams. Some are not well produced, whilst others are not even well drawn. The authors, or their artistic representative, seem to have an unfailing belief that a circle in perspective can be represented by two circular arcs intersecting at sharp angles. This is a gratuitous trap for the unwary.

The style is splendid. The preface is worth reading for its own sake, whilst the historical sketch with Isaac Barrow's prayer will interest even such students as are not excited by Guldinus's and Pappus's theorems.

(4) Many teachers have experienced the want of books on mechanics more advanced than the easy text-books used in schools, and not so advanced as the larger treatises intended for specialists in mathematics. Mr. Fawdry's books are supplying this want, and the present volume is a further contribution to the author's series of books on mechanics. This volume forms the second part of his "Dynamics," and discusses such subjects as differentiation and integration as used in dynamics, harmonic motion, and easy two-dimensional rigid dynamics. The work is well done. The experimental hints, the numerical illustrations of dynamical laws and results, and the very practical examples all help to make the subject attractive and intelligible. There is some lack of logic in the arrangement, and the impression one gets is that of scrappiness. The chapter on harmonic motion, *e.g.*, seems out of place in the middle of a discussion of rigid dynamics.

Mr. Fawdry wastes time in proving that the acceleration d^2x/dt^2 can be written vdv/dx. Surely it must be a part of fundamental dynamical doctrine that:

Number of units of force = time rate of momentum;

Number of units of force = space rate of kinetic energy.

This saves much trouble and memory-searching. One cannot feel angry with a student who forgets the trick of "multiplying by twice the velocity" to get the energy equation.

The figure on p. 271 is unfortunate: when a spiral spring is stretched, the pitch is increased.

One can heartily recommend this as a sound book that will be found very useful both in itself and as an introduction to the larger treatises on the subject.

(5) The fact that a new edition is called for of Prof. Heath's "Solid Geometry" proves that it has been found to serve its purpose as an introduction to those parts of the subject that are required for their practical usefulness. The book, while making no pretence to pedagogical originality, is a very good collection of the most useful theorems and problems in solid geometry. It includes the geometry of the regular solids, spherical geometry, and the mensuration of the sphere. There are a large number of examples with some hints for their solution.

S. BRODETSKY.

VAGUENESS AND DISCRIMINATION.

(1) *The Intuitive Basis of Knowledge. An Epistemological Inquiry.* By Prof. N. O. Lossky. Authorised translation by Nathalie A. Duddington. With a preface by Prof. G. Dawes Hicks. Pp. xxix+420. (London: Macmillan and Co., Ltd., 1919.) Price 16*s.* net.

(2) *Cultural Reality.* By Dr. Florian Znaniecki. Pp. xv+359. (Chicago: The University of Chicago Press; London: Cambridge University Press, 1919.) Price 2.50 dollars net.

IT is extraordinary how difficult it seems to be (and how fearfully long the argument is) to convince a man that what he is quite ready to believe, until you make him doubt it, is true. Natural realism—the theory that the objects of knowledge are in themselves what they are represented to be in our knowledge, that knowledge is the discrimination by the mind of a reality awaiting discrimination—is, I suppose, the philosophical theory of knowledge we all hold until we are philosophers consciously philosophising. Tables and chairs are just tables and chairs, and would be such, so far as their essential form and matter are concerned, were there no mind, or, as the realist prefers to say, were there no act of discrimination, in the universe. We all believe it, but let us once challenge a realist philosopher to prove it—he may be able to, but, unlike the Rabbi called on to expound the whole of the law and the prophets, not while you stand on one foot.

(1) Prof. Lossky's "Intuitive Basis of Knowledge" is admirably translated and very clear and easy to read. The translator, Mrs. Duddington, is eminently qualified for the work, not merely by her knowledge of the original language, but also by what is far more important, her complete sympathy with the philosophical view of the author. The book is prefaced by a particularly lucid "Introduction" by Prof. G. Dawes Hicks, who, though not in entire agreement with the author, is very sympathetic towards his point of view. Prof. Hicks expresses surprise that a professor in a Russian university should have reached conclusions so strikingly in accord with his own, but, though Petrograd may be a long way from London, it is no further from

Berlin and the German universities than London is, and Prof. Lossky is known to many of us by his part in the International Congresses of Philosophy. He is, in fact, thoroughly cosmopolitan so far as his qualifications in philosophy are concerned. The title of his book might lead the reader to expect a theory in accord with some of the more noticeable modern developments, such as Bergson's doctrine of instinct or Croce's æsthetic activity, but intuition has not any such distinctive meaning for Prof. Lossky. He means by the intuitive basis of knowledge merely the vagueness with which the object of knowledge exists undiscriminated, before it is discriminated. This, of course, is the crucial point of realist theory. What it has to account for primarily is "vagueness," in the precise and not vague meaning of the term. According to the realist theory, tables and chairs are, so far as their basis in reality is concerned, the same for men and for guinea-pigs. Apart from acts of discrimination, men and guinea-pigs are on one level of knowledge. What is that? Well, the answer is what the realists are trying to give us, and perhaps if we are patient and allow them time enough they will succeed.

(2) It is not easy to indicate any particular connection between Prof. Lossky's book and Dr. Znaniecki's "Cultural Reality." Their names might suggest that they share an Eastern European viewpoint, if such there be. But, as Dr. Znaniecki is lecturer in the University of Chicago, it is not surprising that the philosophy of the New World—Pragmatism and New Realism—mainly occupies his attention. "Culturalism" is the thesis that there are an objective reality and a subjective adaptation that both change, and change more profoundly than can be expressed by the advance of knowledge by discrimination. It is an attempt to blend the realist theory that there is an object on which the only mental work is discrimination with the pragmatist theory that we make truth. The idea apparently is that from the two separate worlds of things and values there arises a third reality, which is irreducible to either —cultural reality *sui generis*. The primitive material is not conceived as vague, but as a "concrete chaos of historical reality."

H. W. C.

IRON AND STEEL PRODUCTION IN GREAT BRITAIN DURING THE WAR.

The Iron and Steel Industry of the United Kingdom under War Conditions: A Record of the Work of the Iron and Steel Production Department of the Ministry of Munitions. By Dr. F. H. Hatch. Pp. xii + 167. (London: Privately printed for Sir John Hunter by Harrison and Sons, 1919.)

ON account of the vastness of the field covered, the variety and complexity of the technical problems involved, and the far-reaching industrial questions raised, the activities of the Iron and Steel Production Department of the Ministry of Munitions during the war form a subject of surpassing interest and importance. The history of this great work has been written by Dr. F. H. Hatch, himself a member of the Department.

The narrative falls naturally into two divisions, namely, (1) that of the small Steel Department which was formed as a branch of the Materials Department, of which Sir Leonard Llewelyn was director, and (2) that of the much larger organisation formed by Sir John Hunter when he became Director of Iron and Steel Production in August, 1916.

Sir John Hunter was confronted with a very difficult task. The demand for various types of steel for munitions and shipbuilding was growing rapidly while the supply of raw materials essential for their manufacture was threatened with curtailment, if not complete suspension, so far as foreign sources were concerned, by the activity of German submarines. The only sound remedy was the development of home resources, but the substitution of lean phosphoric ironstones such as constitute the main portion of British iron ores for the rich ores imported principally from Spain and the Mediterranean, involved such sweeping changes in plant, supplies, inland transport, labour, etc., that it could only have been carried out with difficulty even in peace-time. Under war conditions it was evident that the problem would require the most skilful handling by a carefully organised department. In spite of difficulties which at times appeared to be almost insuperable, Sir John Hunter's "Basic Iron Program" obtained a high measure of success, and enabled the urgent and incessant calls of the great Service Departments for ship plates, shells, and other munitions requiring steel in their manufacture to be punctually and duly met.

It is a remarkable tribute to the inherent but not always obvious organising power of the nation that under the adverse conditions of a great war it should have been possible to raise the steel production of the country to the highest point it has ever reached in the history of the industry. Under the stress of necessity raw materials which had been allowed to lie dormant in this country were rapidly developed and brought to the producing stage. Iron ores in Oxfordshire, coking coal in Scotland, ganister for silica bricks, moulding sands for foundry work, and refractory sands for open hearth furnace bottoms, are instances in point. Whereas in 1913 and 1914 the total steel output was 7·66 and 7·83 million tons respectively, it had risen in 1917 to 9·71 million tons, and during the first half of 1918 it was at the rate of close on 10 million tons per annum. The plans of the Department provided ultimately for an increase to 12 million tons annually. Dr. Hatch suggests two main reasons for the success obtained; these are (1) the trust reposed by Sir John Hunter in the members of his staff, which was entirely reciprocated, and (2) the fact that manufacturers cordially co-operated in the plans of the Ministry and loyally

concentrated on war work. According to him, many firms readily fell in with the suggestions of the Department to depart from routine practice and embark on experimental work, often at a considerable financial loss to themselves.

OUR BOOKSHELF.

Pre-History in Essex, as Recorded in the Journal of the Essex Field Club. By S. Hazzledine Warren. (Essex Field Club Special Memoirs, vol. v.) Pp. vii+44. (Stratford, Essex: The Essex Field Club; London: Simpkin, Marshall, and Co., Ltd., 1918.) Price 2*s.* 6*d.* net.

THE title "Pre-History in Essex" would suggest that the subjects treated in this special memoir are entirely prehistoric. But we find mentioned papers such as "Fifty Years Ago in Essex," "Tree-Trunk Waterpipes," "The Coming of Age of the Essex Field Club" (1901), etc. Indeed, the number of papers on various subjects mentioned is such that in most cases two or three lines comprise all the explanation of their nature.

Among the few subjects to which more space is given are the Deneholes of Hangman's Wood. Mr. Warren does not take the view given in the report on the Denehole Exploration at Hangman's Wood (*E. Nat.* 1, 1887), but considers that "they possess in every way the normal character of comparatively modern chalkpits" (p. 34). Now about half a mile west of Hangman's Wood is the eastern margin of an area of bare chalk extending thence to Purfleet, besides much smaller exposures of chalk near Little Thurrock and East Tilbury, with modern chalkpits in each place mentioned. Hence modern chalkpits at Hangman's Wood, where the chalk is about 60 ft. beneath the surface, where each pit occupies a very small horizontal space, and is separated from the other pits, and shaped so as to show intended separation, are surely incredible. And the evidence is surely in favour of the E.F.C. Exploration view that these deneholes were family stores. Then the notion of the E.F.C. explorers that *dene*holes meant *den*holes was considered by that eminent philologist, the late Sir J. A. H. Murray, to be incorrect, *dene*holes being *Dane*holes.

However, "Pre-History in Essex" will form a decidedly useful list of the papers published by the Essex Field Club since 1880.

T. V. HOLMES.

The Chemists' Year-Book, 1918–19. Edited by F. W. Atack, assisted by L. Whinyates. Vol. i., pp. vi+422; vol. ii., pp. iv+423–1146. (London and Manchester: Sherratt and Hughes, 1919.) Price 15*s.* net 2 vols.

THE chemical pocket-books used in this country before the recent war were chiefly of German origin. Mr. Atack brought out the first edition of his "Year-Book" in 1915: its appearance indicated that, as with sundry other chemical products and adjuncts, we were quite capable of supplying our own requirements in this respect.

A large amount of information has been packed into the two small volumes. Much of the space is devoted to tables showing the chief physical and chemical properties of numerous organic and inorganic substances—their formulæ, molecular weights, boiling-points, and so on. There are also the ordinary tables of specific gravity, solubility, etc., and much useful matter of a miscellaneous kind, including historical references, mensuration data, and lists of scientific journals. In addition, the volumes include a number of short articles which summarise the theory and practice of various branches of chemical technology. Thus, to mention only a few by way of examples, there are sections on electro-chemical analysis, fuels, dairy products, brewing materials, textile fibres, dyestuffs, tobacco, and photography. These condensed accounts serve to furbish up the reader's acquaintance with branches of work in which he may have become "rusty."

Several new sections have been added to the present edition. They include one on agricultural chemistry by Dr. E. J. Russell, and one on the analysis of ceramic materials by Dr. Mellor. Other parts of the work have undergone a general revision, and chemists will find the "Year-Book" a convenient and useful *vade mecum.*

The Geographical Part of the Nuzhat-Al-Qulūb. Composed by Hamd-Allāh Mustawfī of Qazwīn in 740 (1340). Translated by G. Le Strange, and printed for the Trustees of the "E. J. W. Gibb Memorial." Vol. xxiii. Pp. xix+322. (Leyden: E. J. Brill; London: Luzac and Co., 1919.) Price 8*s.*

WE have here an English translation of the original Persian text of the "Nuzhat-Al-Qulūb" published in this valuable series three years ago. The author, Hamd-Allāh, was a man of note in his day, holding the post of Mustawfī, or State Accountant, to Abu Sa'īd, the last of the decadent Ilkhan dynasty, the first Mongol rulers of Persia, and great-grandson of Hulāqu, the conqueror of Baghdad. The author must have been in possession of much geographical and statistical information, and in many ways his account of Persia and Mesopotamia in the middle of the fourteenth century is valuable; but he depended largely on materials collected by other writers, much of which is now available in published texts. The book takes the form of a gazetteer, but, except as regards places like Qazwīn, the author's native city, little new information is forthcoming. Perhaps the best chapter is that describing the mines of western Asia producing metals, precious stones, and other minerals. His science is that of his own day, that of the scriptures and traditions of Islam, as when he tells us that one of the chief values of mountains is that they prevent the ground from moving. But the treatise abounds in miracles and folklore. Mr. Le Strange's special local knowledge is well exhibited in his identification of many of the obscure places mentioned in the text. The volume is in every way creditable to the editor and to the trustees of the E. J. W. Gibb Memorial Fund.

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.]*

Temperature in the Sun.

WHENEVER a spell of hot weather occurs it is common to see published accounts of the "temperature in the sun." These sun-temperatures have little meaning unless the other surrounding conditions are also stated.

Comparatively few people realise that a thermometer indicates nothing except the temperature of the fluid in its bulb, and that to draw any useful inference from that temperature it is necessary to know how the heat which produced it was supplied.

Heat may enter a thermometer from the air by conduction, aided by convection currents and wind, and also by radiation from distant objects. In general, both these sources contribute to the total.

The true temperature of the air is indicated only when the thermometer is screened from the radiation of any body which is not at that temperature, and the ventilated shelters in which meteorologists place their instruments are intended to secure this condition. In ordinary cloudy and windy weather they answer the purpose, but in sunshine and calms the whole shelter becomes heated, and the thermometer readings are too high.

When a thermometer is fully exposed to the sun a large part of the heat received is supplied by radiation, and the apparent temperature will vary with the character of the surroundings, including the nature of the glass of which the bulb is made.

Of the total radiant energy falling on the bulb part is regularly reflected and the remainder scattered or absorbed, but it is only the energy absorbed during its passage through the glass of the bulb which raises the temperature of the contents—at any rate, in mercury thermometers. The limiting temperature is reached when the surface of the bulb loses, by conduction and dark radiation, as much heat as will balance the supply.

If the bulb is smoked there is scarcely any reflection, and thus a bulb coated with lampblack will reach a higher temperature than a black glass bulb, and this, in turn, will be higher than if the glass is transparent, and if the exterior of the bulb is silvered there will be an even greater difference.

Thus, in the same place and in the same sunlight, four different temperatures might be indicated by accurate thermometers, each reading differing from the others by several degrees, the differences depending on the different absorptive and emissive qualities of the glass and its surface.

The actual difference between the apparent "temperature in the sun" and the air temperature may in this country be as great as 50° F. In the tropics I believe it may be considerably more.

Darwin, when in the Galapagos Islands, wrote:—"On two days the thermometers in the tent stood for some hours at 95°, but in the open air in the wind and sun at only 85°. The sand was extremely hot; the thermometer placed in some of a brown colour immediately rose to 137°, and how much above that it would have risen I do not know, for it was not graduated any higher. The black sand felt much hotter. . . ." The true air temperature was probably about 80°, so that the sun's radiation heated the ground 60° or 70° more than air.

I remember seeing in a sunny window in January the thermometer standing at 108° when the room temperature was about 60°; and in the recent warm weather, when the air temperature was about 80°, a thermometer shielded from draught by a thin smoked glass tube indicated 128°.

These facts show how little meaning can be attached to "temperatures in the sun" unless all the conditions are stated.

If a blackened thermometer is enclosed in a good vacuum chamber of transparent glass, and is carefully screened from all ground radiation, its readings in the sun will give a good comparative measure of the transparency of the air to radiant heat; but if the true temperature of the air is required, the thermometer should be surrounded by two or more concentric silvered glass tubes through which a rapid draught is maintained. In this way the effects of radiation are almost eliminated, and all the heat received is supplied by conduction.

A. MALLOCK.

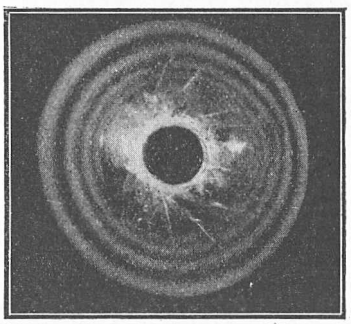
6 Cresswell Gardens, South Kensington.

Percussion Figures in Isotropic Solids.

THE accompanying photographs are of interest as illustrating the manner in which an isotropic solid breaks down under the stresses set up by impact when these exceed the limits of perfect recovery, and have a bearing on the theory of the collision of elastic solids developed mathematically by Hertz.

Figs. 1, 2, and 3 are pictures of the percussion figure, taken from three different points of view, produced on the surface of a thick glass plate by the impact of a polished hard steel ball. Near the centre of the region of contact between the sphere and the plate the stresses are mainly in the nature of a volume-compression, and fracture accordingly does not originate there, but occurs at or near the *margin* of the compressed area in the form of a fine circular crack which spreads inwards into the plate obliquely in the form of a surface of revolution. This is clearly shown in Fig. 1, which is a front view of the percussion figure by reflected light, the dark circle in the middle being the uninjured area of contact between ball and plate. The circular interference-rings seen in the picture are a measure of the separation of

FIG. 1.



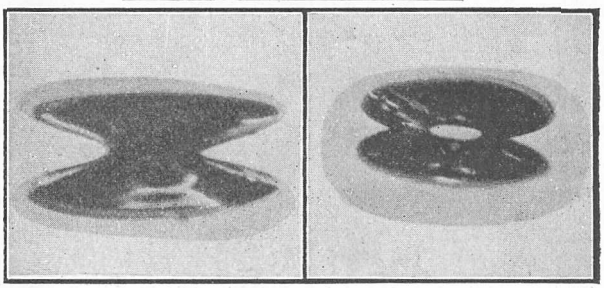


FIG. 2. FIG. 3.

the surfaces of the internal fracture within the plate.

Fig. 2 is a side view, and Fig. 3 an oblique view, of the internal fracture seen through the edge of the plate, the lower half of each picture being the image of the upper half formed by the reflection of light at the interior surface of the plate. The circular area of contact from the margin of which the fracture starts appears in Fig. 3 as an elliptic white disc at the centre. It seems clear that the internal fracture practically occurs along the surface of maximum *shearing* stress set up during the impact. C. V. RAMAN.

210 Bowbazaar Street, Calcutta, August 18.

The Rigidity of the Earth.

AN account of an experiment to determine the rigidity of the earth was published in the *Astrophysical Journal* and in the *Journal of Geology*, March, 1914. This gave the ratios of the amplitudes of tides observed in N-S and E-W pipes to the amplitudes computed for the same pipes on the assumption of a perfectly rigid earth as 0·523 and 0·710 respectively.

The work of reducing a new set of automatically recorded observations made by an interference method, which was interrupted by the war, was recently resumed, and it was found that the N-S and E-W ratios were very nearly equal to each other.

It was then noted that $0{\cdot}523/0{\cdot}710=0{\cdot}7366$, and that the cosine of the latitude of Yerkes Observatory, where the experiment was performed, is 0·7363. It seemed highly probable, therefore, that $\cos\phi$ had been introduced erroneously into the computed formula for for N-S tides.

We have just been informed by Prof. Moulton that he has gone over the old formulæ used, and has found that the computer introduced the factor $\cos\phi$ erroneously into the N-S computation.

The N-S ratio should therefore have been $0{\cdot}523/0{\cdot}7363=0{\cdot}710$, which, oddly enough, is exactly equal to the E-W ratio.

The new observations point to a value of about 0·69 for both E-W and N-S ratios.

A. A. MICHELSON.
HENRY G. GALE.

University of Chicago, September 10.

The "Flying Gallop" in Art.

IN NATURE of August 21 (p. 489) reference is made to a popular article by Mr. C. W. Bishop on "The Chinese Horse," and to the distribution of the artistic motive of the flying gallop dealt with in it. It may be of interest to remark that this problem was first studied and discussed by the famous French archæologist S. Reinach in his "La représentation du galop dans l'art ancien et moderne" (Paris, 1901), and was afterwards expanded by me in my book, "Chinese Pottery of the Han Dynasty" (Leyden, 1909), where also many illustrations of the motive from Chinese art-works are given.

B. LAUFER,
Curator of Anthropology.

Field Museum, Chicago, September 10.

MUSEUMS, EDUCATION, AND THE BOARD.

FOR many years a number of our provincial museums have striven to make their collections of educational value, both to the ordinary citizen through their exhibits and guides, and to the schools through their exhibits and special circulating collections, as well as by talks to the teachers or pupils. The response of the education authorities long continued disappointing, but some eight or ten years ago things began to move more rapidly. Certain pure educationists began to see that there was something of value for them in the museums, and in 1913 the Educational Science Section of the British Association appointed a strong committee to report on the question. The war, though unfortunately preventing the publication of that committee's lengthy report, and hindering museum activities in many directions, has had the result in some towns, notably Manchester, of inducing the schools to lighten their own troubles by seeking the aid of the museums and their staffs.

So well had the movement progressed, thanks mainly to the insistent propaganda of museum officials, individually and through the Museums Association, that at last the Education Act of 1918 and the draft suggestions for the arrangement of schemes thereunder (Circular 1096) took museums into serious account as an educational factor. Museum enthusiasts were delighted. But now comes a move which gives them pause. The Adult Education Committee of the Ministry of Reconstruction has issued an interim report (Cd. 9237) recommending that public libraries and museums should be placed under the control of the local education authorities, and administered by special committees of those bodies, and urging "that the powers and duties of the Local Government Board regarding public libraries and museums should be transferred forthwith to the Board of Education." So reasonable a recommendation would, it is doubtless expected, be welcomed effusively by the institutions concerned. The contrary is the case. The protests of the librarians are quoted—and dismissed—in the interim report itself. They have just been repeated at the meeting of the Library Association in Southport, but we cannot consider them here. As already reported (NATURE, July 17, 1919, p. 394), the Oxford meeting of the Museums Association raised so many objections that it appointed a committee to prepare a statement. And now, in a discussion of the Educational Science Section of the British Association, the opposition of the museums found vigorous expression, and such support as the proposal received from one or two curators was only half-hearted. It may be well, therefore, to summarise the arguments.

The Adult Education Committee holds its opinion so strongly that it has condescended to very little argument. We gather more from a paper laid before Section L by Prof. J. A. Green. This assumes that museums are "fundamentally educational in character," and infers that they should form part of the educational machinery of the country. This machinery should be controlled by one authority, and its parts adapted to a common aim. This would change the outlook of the museums and lead them to display their collections in such a way as to dispel "museum headache." The responsibilities of the Education Committees have been extended to adult education, and they would be better able to bring museums

into touch with universities and other of the higher educational establishments. Where a museum does not exist already, as in certain towns and in country districts, a live education authority would set one up, so that the number will be increased. Museums suffer from want of funds because few are supported by more than a ½*d.* rate, some not even by that; they would receive grants in aid directly from the Board of Education.

To this the museums reply that they recognise the argumentative force of a pecuniary bribe; but if their work is worthy of this reward, why should it not be given? For the rest, they dispute the premisses. A museum is *not* fundamentally an educational institution. It exists primarily for the collection and preservation of the works of nature or of man, and its highest aim is the advancement of science or of art. The needs of the researcher must never be sacrificed to those of the elementary student or the public. Even the smallest local museum has a duty in this direction, and it is this spirit which keeps the museum alive. Museums which themselves chart the unknown seas of knowledge can best pilot the learners. Organised education is the vehicle of established knowledge, is necessarily limited in scope, and must move on the rigid lines of a syllabus; but the museum must respond to new influences, must extend knowledge, and assemble material for future research. The existing museum committees are not ideal, but neither are the education committees. The curator knows his men, has been moulding their ideas, and has generally found a chairman with large views. He does not wish to see either himself or his chairman controlled by a body the scope of which embraces but a subsidiary part of his museum's activities. If his means of support are to come solely through educational channels, results will be expected through those channels alone. The others will gradually be blocked, the level of aspiration and accomplishment will be lowered, the living water will stagnate. Museum officials, from experience or observation, distrust bureaucratic government; they want men whom they can approach, not an anonymous Board.

Compromise, however, may be possible. Co-operation is desired, though not subordination. Let the education authority advise upon the public exhibition series, and support financially the educational work of the museum in proportion as it approves. But hands off the unseen activities of the museum! Provincial museums may be linked up with one another and with the national museums above and the minor museums below, but the linking should be through a body representative of their own committees and curators. If the source of money must be the Board of Education, so be it; but let it flow to these committees through a separate museum department of the Board. Museums here, as in the United States, have shown what good educational work they can do on their own initiative. Recognise that initiative, and they will respond with more abundant and more fruitful efforts.

THE COALFIELDS OF SPITSBERGEN.

COAL is not a new discovery in Spitsbergen. It has been known for more than 300 years, and about a century ago small cargoes were even brought to Norway. But mining on a serious scale did not begin until some fifteen years ago, while its rapid extension is due to the high price and comparative scarcity of coal during and after the war. There are now at least four mines in Spitsbergen exporting coal in large quantities during the summer months, and several others which will soon reach the export stage.

Coal of at least three ages occurs—Carboniferous, Jurassic, and Tertiary. It is difficult to give the total content, but it may safely be said that Spitsbergen coalfields do not contain less than 5,000,000,000 tons. Bear Island, in addition, has a content of some 8,000,000 tons. The occurrence of drowned fault valleys in the plateau of almost horizontal strata has made the coalbeds easily accessible in most places, and greatly facilitates loading by reducing land transport to a minimum. Practically all the valuable coalbeds lie around the two great inlets on the west coast—Icefjord and Lowe Sound—except a small outlier of Tertiary coal in King's Bay, near the north-west corner of Spitsbergen. The Tertiary coal has attracted most attention, and for the present at least provides most of the export coal. At Longyear City, the prosperous Norwegian mine in Advent Bay, several seams have been located at 755 ft. above sea-level; a 3½-ft. seam is now being worked, and at 815 ft. a 4½-ft. seam is being opened; another seam occurs at 640 ft. The same coal is being worked in Lowe Sound and in Braganza Bay. In the latter place Swedes are exporting large cargoes from their mine in the 3½-ft. seam at a height of 245 ft. It is also being mined successfully by Russians in Green Harbour.

The Tertiary coal has been proved to be a good steam coal of high calorific value, and fairly free from dirt. An average of the analysis of several samples gives about 79 per cent. carbon, 2 to 6 per cent. water, less than 2 per cent. sulphur, and about 4 per cent. ash. The calorific value averages about 7800. The seams appear to maintain a fairly consistent thickness and uniformity in quality over wide areas. Other seams of Tertiary coal also occur, notably a 7-ft. seam of bituminous coal in Advent Bay at a height of 1900 ft. This seam, which is now being mined, shows a slight tendency to pass to lignite, an unusual feature in Spitsbergen Tertiary coal.

The coal of Carboniferous age occurs in the culm beds near the foot of the Carboniferous system. The deposits are very extensive, but have been investigated only recently, and so have attracted less notice than the Tertiary seams. Moreover, the outcrops of these coal seams are generally obscured by enormous screes and slip masses, so that their examination entails a good deal of serious work, including boring operations; but this is well repaid, as the seams are thick, and extend over wide areas round the northern

and eastern bays of Icefjord. In the Klaas Billen district valuable seams have been opened up at various heights. Varying from a few inches to about 3 ft. in thickness, they total 6 ft. Early analyses of Carboniferous coal were vitiated by the samples being taken from weathered slip masses, in consequence of which they showed a high proportion of ash. Now, however, that the coal has been reached *in situ*, it proves to be of high quality, clean and lustrous, and, unlike the Tertiary coal, fit for coking. Projects are on foot for extensive mining operations in these fields.

Jurassic coal is widely spread, but less accessible than the other kinds. It was the first coal to be mined, but turned out to be of relatively poor quality, and is now no longer worked.

Mining is continued throughout the year, although the export season at present extends only from June to September. The miners winter in comfortable timber houses, and are well supplied with fresh food, brought from the European mainland in the autumn. There is wireless communication throughout the winter. The restriction of export to four months in the year necessitates good storage facilities for the winter coal and rapid loading in summer both from the dump and direct from the mine, but these problems are being satisfactorily solved. The total coal export of Spitsbergen, which in 1913 was 35,000 tons, rose last year to 65,000 tons, and this year must have reached about 100,000 tons. These figures are, of course, comparatively small, but they will be much increased as several new mines get into working order. The shortage of labour, material, and tonnage still affected the output this season, but it may be said that the prejudice against mining in the Arctic has now been overcome, and Spitsbergen will soon take its due place as one of the important coal-producing countries of Europe. R. N. R. B.

NOTES.

THE Ministry of Munitions has published as a confidential document a highly interesting report of the Commission appointed to visit the iron and steel works of the occupied areas of Germany, also of Lorraine, Luxemburg, and certain portions of Belgium and France. The object of the Commission was to ascertain what developments in iron and steel manufacture have taken place during the war, the present condition of the plants, the future prospects of these areas, and to what extent fuel economy has been advanced therein. As regards the last-named item, Messrs. Cosmo Johns and Lawrence Ennis communicated to the recent autumn meeting of the Iron and Steel Institute a report on the present status of fuel economy in the German iron and steel industry of the occupied territory. This report is now public property, and contains very much interesting material; it may be taken as an indication of the importance of the valuable information which the Commission itself has collected. It is to be hoped that the Ministry of Munitions will see its way to publish the entire report as an ordinary Government publication purchasable in the usual way, so that it may be known by all engaged in the iron and steel industries in this country, as there is no reason why our industries should not be allowed the benefit of the careful studies of this Commission. Such an important document should be made available as widely as possible to all those interested in the subject-matter.

THE future of the Royal Botanic Society at Regent's Park has for long been a matter of anxiety, and the recent appointment by Lord Ernle, when President of the Board of Agriculture and Fisheries, of a strong Committee to inquire and report as to what steps should be taken to render the work of the society as useful as possible, from the scientific and educational points of view, was a most welcome step. The Committee, under the chairmanship of Sir David Prain, Director of Kew Gardens, has taken evidence from representative botanists and others, and its report is now available. Apart from the establishment of the gardens at Regent's Park, the primary object of the society, which was incorporated in 1839, was "the promotion of botany and its application to medicine, arts, and manufactures." It is interesting and satisfactory, therefore, to note that the Committee is of the opinion that the usefulness of the work of the society would be enhanced by the organisation and development of botanical work essentially economic in its bearing. The chief suggestions made by the Committee are:—(1) The establishment of a school of economic botany at which a knowledge of economic plants and their products could be obtained; (2) an institute which might be made a centre for research, especially in plant physiology; and (3) a centre for teaching practical horticulture. The first is the most notable and valuable recommendation. The establishment of such a school would supply an undoubted want in this country, where organised instruction in economic botany, especially as regards tropical crop plants, is almost impossible to obtain. The Committee is to be congratulated on so accurately judging the need of the situation. It is greatly to be hoped that the financial means necessary for the successful carrying out of the Committee's recommendations will be forthcoming.

A MEETING of the Executive Committee of the United States National Research Council was held at the National Research Council Building, Washington, on April 15 last, and according to an abstract, 21 pages in length, of the minutes, which appears in the July issue of the Proceedings of the National Academy of Sciences, the Council has already made great progress in initiating and co-ordinating research in pure and applied science in the States. It has organised divisions for physical science, chemical science, geology and geography, biology and agriculture, engineering, industrial, educational, and State relations. Each division is presided over by a man of note, and on it there are many representatives of scientific and other societies. The Council will have ample funds at its disposal, the Rockefeller Foundation alone having undertaken to provide 100,000*l.* during the next five years for the promotion of fundamental researches in physics and chemistry primarily in educational institutions. The chairman of the Council receives 2000*l.*, and chairmen of divisions 1500*l.*, per annum, with travelling expenses. The Council is to be congratulated on the speed with which it has accomplished so much.

DR. THEODORE W. RICHARDS, professor of chemistry at Harvard University, has (*Science* announces) been elected president of the American Academy of Arts and Sciences.

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THE Secretary of the Department of Scientific and Industrial Research informs us that a British Association of Research for the Cocoa, Chocolate, Sugar, Confectionery, and Jam Trades has been formed in accordance with the Government scheme for the encouragement of industrial research. The secretary is Mr. R. M. Leonard, the Manufacturing Confectioners' Alliance, Ltd., 9 Queen Street Place, E.C.4.

A COMMITTEE has been formed to raise a fund by public subscription for the purpose of establishing a memorial to perpetuate the memory of the eminent services, particularly in the fields of economics and science, rendered to Tasmania by the late Mr. R. M. Johnston, for many years Government Statistician and Registrar-General of that State. Subscriptions are now invited, and should be sent to Mr. T. A. Tabart, jun., honorary treasurer, Cathedral Chambers, Murray Street, Hobart, or Mr. Clive Lord, honorary secretary, c/o Museum, Macquarie Street, Hobart.

BY the untimely death of Prof. F. J. Haverfield, Camden professor of ancient history, the University of Oxford has lost a valued member and the first living authority on Roman Britain. Early in life Prof. Haverfield devoted himself to this, his special subject, and his reputation caused Mommsen to entrust to him that portion of the "Corpus Inscriptionum" which dealt with Great Britain. Not only was he a master of the literature of the Romano-British period, but he gave much assistance to excavations at Silchester, Caerwent, and the Roman Wall. He was an admirably stimulating lecturer, and was interested in town-planning in ancient times, on which he wrote a valuable book. Late in life he devoted himself to the question of university finance. It may be said that the Camden chair was never more worthily held by a scholar and practical archæologist. It is a matter of deep regret that ill-health prevented Prof. Haverfield from preparing the authoritative work on Roman Britain which he had planned, and alone could have accomplished.

WITH the mathematician Philip Edward Bertrand Jourdain there died on October 1 a truly remarkable character. Jourdain lived only thirty-nine years, but the amount and value of the work that he accomplished, considering the disabilities under which he laboured, are almost incredible. He was weakly from infancy, and as a child developed symptoms of the progressive paralytic condition known as Friedreich's ataxia. In spite of his unsteady gait and constant ill-health, he early showed great mathematical and mechanical capacity. He went up to Cambridge in 1898, then already a cripple. During his course at Cambridge he spent some time in Germany and became a fluent and scholarly linguist, speaking and reading several European languages. In 1904, though now physically quite incapacitated, he was awarded the Allen mathematical scholarship for research, and throughout the remainder of his short career his main activities were directed to the prosecution of mathematical investigations. His most important work was the discovery of certain series of infinite numbers. Working with Russell and Whitehead, he showed that certain arithmetical processes could be applied to them, and thus he obtained new and interesting results. He continued on this line of research, and even a few days before his death, of the imminence of which he was fully aware, he succeeded in demonstrating the existence of a previously unsuspected series of infinites. His very last work was the discovery of a formula for the well-ordering of *any* aggregate. Notes of this work are now, we understand, in the hands of Prof. Love. Jourdain contributed extensive mathematical articles to the last edition of the "Encyclopædia Britannica." He founded and edited the *International Journal of Ethics*. He was for some years the English editor, and since the death of Carus in 1918 the chief editor, of the *Monist*. He also made a number of translations of scientific works for the Open Court Publishing Co. Jourdain took the liveliest interest in the movement for encouraging the history of science. He was a contributor to *Isis*, and at the time of his death he had in preparation an article for the "Studies in the History and Method of Science" which it is hoped he may have left in a state ready for publication.

IN *Man* for September Col. de Guérin, of Guernsey, expresses the opinion that the megaliths in that island may be much more recent than they were hitherto supposed to be. This view is based on the important discovery of traces of a rudely sculptured human figure on a capstone of the great chamber of the dolmen of Déhus. The relationship of this figure to similar anthropomorphic sculptures in Guernsey and France is obvious, and as these latter, according to Déchellete and others, date at earliest from late in the Neolithic, at the verge of the Æneolithic period, the dolmen of Déhus must be of this age or later. This is confirmed by the discovery in 1847 of a copper knife-dagger in the great chamber of this dolmen. Col. de Guérin fixes also the statue Menhir at the Cátel Guernsey in the first Bronze age. He lays special stress on the evidence of a still earlier seaborne trade with Brittany in the numerous celts of jadeite and other foreign rocks found in the island.

IN the nineteenth volume of *Natural History* (Nos. 4–5, April–May, 1919) Mr. I. M. Clarke describes, with numerous excellent photographs, the new Gaspé bird sanctuaries established by the Canadian Government on Percé Rock and Bonaventure Island, off the Gaspé Peninsula, and, further out in the Gulf of St. Lawrence, the Bird Rocks of the Magdalen Islands. The efforts of ornithologists for bird-protection have at last proved successful with the support of the Hon. Honoré Mercier, Minister of Colonisation, Mines, and Fisheries for the Province of Quebec. In another article on the same subject Mr. A. M. Bailey describes the Hawaian Island Reservation, which was established in 1909 by Executive Order as a sanctuary for the millions of sea-birds and waders which return there annually to raise their young or to rest while migrating. For this and other generous measures to preserve bird-life, science is indebted to the late Theodore Roosevelt.

Natural History (vol. xix., Nos. 4–5, April–May, 1919) publishes a series of articles on zoological sculpture in art and architecture. Mr. S. B. P. Trowbridge, dealing with architecture, beginning with the palæolithic horse frieze at Cap-Blanc and the horse painting from Altamira, reproduces photographs of the bas-reliefs of Assyria in the British Museum and the Rostra at Rome. In regard to modern art, he accounts for the comparative failure of modern attempts on the ground that "in the art of sculpture, as in all art, there must be sincerity and truth, accuracy in delineation and fidelity in modelling, and the suppression of every detail unnecessary to expression." This idea is pursued in Mr. C. R. Knight's account of the work of contemporary American artists dealing with animal life. The black rhinoceros and African buffalo by Mr. J. L. Clark have some impressive vigour; but the zoological statuary at Washington, described by Mr. R. W. Shufeldt, shows little dignity or power of expression.

The lions, tigers, and buffaloes are distinctly inferior to the Nineveh hunting scenes described in the previous article.

MR. V. STEFANSSON describes his successful method of Arctic exploration in an interesting article entitled "Living Off the Country" in the May issue of the *Geographical Review* (vol. vii., No. 5). Mr. Stefansson's well-known adoption of Eskimo habits and diet have enabled him to travel with very light loads and to penetrate far into the unknown for long periods without any anxiety. He contends that from experience he has found that a diet of flesh or fish is quite sufficient to sustain a person in good physical and mental condition, and that salt is not necessary for health. White men whom he has known to have lived for a year or more on an exclusive meat diet have shown no desire to return to the varied and elaborate diet of civilisation. So convinced is Mr. Stefansson of the abundance of food in the Arctic lands and seas he knows that he asserts that any man conversant with the ways of wild animals and the hunting and living methods of the Eskimo can load on one dog-team all the equipment he needs for a journey of several years. Where previous explorers had carried food and fuel, Mr. Stefansson carried neither, choosing to adapt himself to his environment rather than fight it. Instead of taking food and fuel he carried merely the instruments for obtaining them. By economy in the use of ammunition one can obtain as much as two tons of food for a pound of ammunition, or, in other words, ammunition is several thousand times as economical to carry as the most condensed kind of food. The paper deals at length with the methods of Arctic hunting, particularly seal-stalking.

IN his presidential address to the seventeenth meeting of the South African Association for the Advancement of Science, held in July last, the Rev. Dr. W. Flint discussed the thorny problem of "Race Consciousness" in the light of modern scientific opinion. He regarded "national consciousness" as a mental tendency which had been fostered among the peoples of Europe, by territorial and linguistic boundaries, and by the propagation of a community of ideas. "Race consciousness," as seen in South Africa and in the Southern States of America, on the other hand, was an inherent proclivity or "property of human nature," and demanded the closest scrutiny and most accurate study on behalf of all men of science if political bankruptcy was to be avoided. In Spanish America racial animosities had been dissolved by miscegenation, but that method was unthinkable as a solution of South African racial difficulties. There was also another plan, the proposal to segregate native races in demarcated territories, but in practice that proved an impossible working policy. There was a third proposal which had been debated, the frank recognition of racial antagonism and the resolution on the part of each race to live within its own armed camp. The solution advocated by Dr. Flint was none of these, but the cultivation and recognition of an "international consciousness," which could be fostered by education and by the recognition on the part of "superior" peoples that every race has its rights, economical, political, and social. Dr. Flint holds that "racial consciousness" can be uprooted and replaced by an intellectual "inter-racial consciousness," and that racial conflicts can be avoided only by education—of whites as well as of blacks. On the biological significance of "race consciousness" Dr. Flint did not attempt to throw any light; that is a matter which still awaits patient investigation. Everyone interested in the problems of racial contact will find food for thought and subjects for observation in Dr. Flint's presidential address.

THE Board of Agriculture has received the following information from the International Agricultural Institute at Rome:—The yield of wheat in Spain, Scotland, Italy, Canada, the United States, India, Japan, and Tunis is estimated at 929,525,000 cwt., or 5·6 per cent. below the 1918 crop, and 1·1 per cent. below the average yield of the five years 1913–17. The estimated production of rye for Italy, Canada, and the United States is given as 48,274,000 cwt., or 7·1 per cent. below last year's production, but 67·3 per cent. above the average crop for the years 1913–17. The barley crop for Scotland, Italy, Canada, the United States, Japan, and Tunis is estimated at 159,397,000 cwt., or 15·1 per cent. below last year's production, and 4·1 per cent. above the average production of the years 1913–17. The estimated production of oats in Scotland, Italy, Canada, the United States, Japan, and Tunis is 491,933,000 cwt., or 18·4 per cent. below the 1918 yield, and 7·2 per cent. below the average yield of the five years 1913–17. The maize crop in Italy, Canada, and the United States is estimated at 1,473,592,000 cwt., or 10·2 per cent. above the 1918 production, and 3 per cent. above the average yield of the years 1913–17.

THE flora of Aldabra and other small islands of the western Indian Ocean is the subject of an article by Dr. Hemsley in the Kew Bulletin (No. 3, 1919). Aldabra is an atoll, similar in size to the Isle of Wight, 220 miles north-west of Madagascar, and about 600 miles from the Seychelles Archipelago. Assumption, the nearest island, is about twenty miles distant. Aldabra is densely clothed with vegetation, which is unusually rich for an atoll flora, comprising herbaceous, shrubby, and arboreous species. Excluding species introduced by human agency, the flora comprises more than 170 species of flowering plants, representing 127 genera and 54 families, proportions which are characteristic generally of insular floras. Grasses number 14 species, Rubiaceæ 15, and Leguminosæ 12. The Rubiaceæ constitute the predominating element in the woody vegetation, both as to number and diversity of genera and number of species, but are less conspicuous in the scenery than the mangroves, the figs, and a species of Euphorbia. The vegetation consists of four types:—(1) Mangrove swamp, which fringes the lagoon. (2) Pemphis bush, a dense growth of the hard-wooded *Pemphis acidula* (Lythraceæ), a widely distributed sea-coast plant. (3) Open bush, mostly of low trees and bushes, which are usually leafless in the dry season and flower at the beginning of the rains; herbaceous plants are scarce, and only found in the wet season. Almost all the Aldabra plants are to be found in this type of country. (4) Shore zone, extending round the atoll, varying much in width and supporting some widely distributed littoral species. The coco-nut, of which there are conspicuous plantations, is regarded as an introduced plant. Dr. Hemsley is convinced that this palm is a native of South America, the home of all the numerous species of the genus, and that its present wide distribution is due to human agency. Some particulars are also given of the floras of other islands in the western Indian Ocean, and of their relations with the flora of Aldabra. The data collected point to the common origin of the flora of Aldabra and the neighbouring islands, and indicate that the flora is essentially African and almost without any infusion of a Malayan element, such as exists in the Seychelles and the Mascarene Islands.

OCTOBER is a transition month so far as winds and distribution of atmospheric pressure are concerned in the East Indian Seas, and the Monthly Meteorological Chart published by the Meteorological Office shows that a considerable change is taking place in the general meteorological conditions. To the north of the equator northerly winds are decidedly asserting themselves and the south-west monsoon of the summer months is giving way. In the Bay of Bengal and in the Arabian Sea, October and November are the most stormy months of the year, and cyclones are more numerous than at any other period. The low barometric pressure which has prevailed over the land to the north of India is giving place to higher barometer readings, which causes a diametrically opposite wind circulation. The chart contains an interesting note of sea phosphorescence in the vicinity of Madras on July 3. At 2.10 a.m., in latitude 12° 43′ N., longitude 30° 34′ E., the steamship *Clan Ogilvy* (Capt. W. M. Porterfield) passed through what appeared to be a gigantic wheel, with many "curved" spokes, revolving the same way as the hands of a clock. The phenomenon lasted quite ten minutes, and is said to have been caused by phosphorescence. The wheel was travelling to the eastward. As each "spoke" passed, the ship was lit up.

THAT the war has done a great deal to show the value of the spectroscopic examination of metals and alloys is proved in an article on the subject in *La Nature* (September 6). Considerable information was gleaned regarding the composition of secret German alloys which were investigated by A. de Gramont by his method, and the same remark applies to the composition of the metal used by the enemy in the manufacture of the long-range shells fired upon Paris. The spectroscopic method would seem to be of particular value when applied to the examination of the constituents of alloy steels and commercial alloys, and, as the writer states, is capable of great expansion in this direction.

MESSRS. LEVER BROS., LTD., Liverpool, have lately published an interesting "Cattle Food Calendar" for 1919–20. This contains articles on the scientific side of agriculture written by men competent to speak on their respective subjects. Further, it is illustrated by photographs and pictures of many of the important operations in agricultural science. Among the articles we note "How Mendelism May Help the Stock-breeder," and shorter, but equally interesting, articles on "The Work of the Board of Agriculture," "Plant Diseases," "The Relation between Skin-temperature and the Fattening Quality of Cattle," "The Official Seed-testing Station at the Food Production Department," "The Work of the Rothamsted Experimental Station," "The Breeding of New Wheats," "Warble Maggots in Cattle," "Investigation and Research in Dairying," "Contagious Abortion in Cattle," "Horticultural Research," "The Cheshunt Experimental and Research Station," and "Forestry." The list covers a wide field, and the articles give brief, but useful, summaries of the application of science to agriculture.

OUR ASTRONOMICAL COLUMN.

COMET 1919*c*.—The following is a continuation of the ephemeris of comet 1919*c* (Metcalf-Borrelly) for Greenwich midnight:—

		R.A.			N. Decl.				R.A.			S. Decl.	
		h.	m.	s.	°	′			h.	m.	s.	°	′
Oct.	9	15	38	25	5	11	Oct.	21	16	10	14	1	17
	13	15	48	38	3	4		25	16	21	39	3	30
	17	15	59	14	0	54		29	16	33	30	5	43

Log *r* and log Δ on October 9, 0·1574, 0·3052; on October 25, 0·1106, 0·2884. The comet is an evening object, and is getting inconveniently near the sun.

A FAINT NOVA.—Miss Mackie announces that she has discovered a nova from a study of the Harvard photographs (Harvard Bulletin 691). Its position is R.A. 20h. 3m. 4s., N. declination 17° 24·3′ (1900). It follows a 14th magnitude star by 0·2s. It reached its maximum, 7·2 magnitude, on November 22, 1913, and has now sunk to below 14·5. The position is in Sagitta, within the limits of the galaxy; it is only about 26° from Nova Aquilæ.

HINDU SPHERICAL ASTRONOMY.—Mr. G. R. Kaye has published a paper on "Ancient Hindu Spherical Astronomy" in the Journal and Proceedings of the Asiatic Society of Bengal (vol. xv.). In this he summarises, with the aid of modern mathematical formulæ, the fundamental portions of the principal classical astronomical texts, which date from between A.D. 498 (the *Aryabhatiya*) and about A.D. 1000, when the redaction of the *Surya Siddhanta* now extant was written. Indian trigonometry is, like Indian astronomy, of Greek origin, but the Indians developed the methods received from the Greeks in various ways. There seems to be no doubt that the Indians were the first to introduce the use of sines instead of chords, and to compute tables of sines. But they never went further, and did not make use of the tangent function. They never give a proof of any rule they enunciate. The title of Mr. Kaye's paper refers to spherical astronomy only, but the author also gives a short account of the Hindu notions of the motions of the planets, though this has been done by several previous writers. The Hindu planetary theories differ in several details from those of Ptolemy, and were probably mainly derived from Alexandrian writings from the period between Hipparchus and Ptolemy, now lost. Though there is nothing particularly new in Mr. Kaye's paper, it gives a convenient summary of the principal doctrines taught in the great Indian astronomical text-books.

STELLAR CLUSTERS.—Dr. and Mrs. Shapley contribute another paper to the *Astrophysical Journal* for July on stellar clusters. They give a table of forty-one clusters, of which thirty show ellipticity, eleven are sensibly circular, and one is unsymmetrical. The most elliptical cluster is Messier 19, in which the greatest diameter is about twice the least; this is a much lower degree of flattening than that in the galaxy or the spiral nebulæ. In the case of the circular clusters, the form may be real or it may be due to our being situated near their polar diameters. There is some evidence that clusters near the galactic plane tend to have their equatorial planes parallel to it. At a distance from the galactic plane this no longer holds.

THE AURORA OF OCTOBER 1.

THERE was noteworthy auroral activity on the night of October 1. The display started in the early evening and lasted until well after midnight. As seen in the south of England, the aurora was generally of the glow type. The absence of streamers, etc., was commented on by Mr. W. H. Dines, of Benson Observatory, but Capt. J. E. Cowper noted streamers at Shanklin, Isle of Wight, soon after 22h. 15m.[1] The colour of the glow, which was comparable in effect with bright moonlight, was reported as "pale white" at Benson, "greenish-yellow" at

[1] According to the *Times* of October 3 there was a brilliant display with streamers seen from Worcester Park about 1 30 on October 2. "Curtains" were seen at Newport between 21.30 and 23 on October 1.

Shanklin and also at Ross-on-Wye, and "reddish-yellow" at Newquay.

The display was first noticed at Bristol at 9.15, and the final traces of it disappeared 5¾ hours afterwards, viz. at 15h. G.M.T. The appearance was that of a band of luminosity lying just over the northern region of the sky and extending over about 70° from nearly north-west to north-east. From this intense glow streamers occasionally shot upwards, but these quickly broadened and disappeared. They showed a reddish tint, and in several cases could be traced nearly to the altitude of Polaris. The stars of Ursa Major were deeply involved in the aurora, but shone conspicuously amid the light surrounding them.

At first sight a person might have mistaken the aurora for the reflection of a widespread conflagration, but a little watching revealed the precise nature of the event. Clouds covered a large portion of the sky at times, but it seemed curiously to avoid the region affected by the phenomenon, and there were showers of rain at intervals. The brilliancy of the northern light and the darkness of the clouds in other parts offered a striking contrast. Several meteors were seen during the night radiating from a point at 355°+40°.

A letter from the Isle of Man describes a brilliant aurora visible there at 8.45 G.M.T. on the same night, and continuing with various modifications for several hours.

Dr. C. Chree has supplied the following note on the simultaneous magnetic storm as recorded at Kew Observatory, Richmond:—

"A smart magnetic storm was simultaneously experienced in connection with the aurora. As recorded at Kew Observatory, it began with a well-marked S.C. (sudden commencement) about 16h. 12m. G.M.T. on October 1, and continued until 4h. on October 2. The approximate ranges were 32′ in D, 280γ in H, and 170γ in V. The extreme westerly position was reached at the end of the S.C. about 16h. 16m., the extreme easterly position about 23h. 25m. on October 1. Between 22h. 18m. and 22h. 50m. there was a swing of 29′ to the east. The maximum in H appeared about 17h., the minimum shortly before midnight. After the minimum there was a rapid recovery from the depression. As usual in storms, V was enhanced in the afternoon, the maximum appearing about 19h. 10m. There was, however, a second approximately equal maximum about 22h. 15m. This was preceded and followed by somewhat rapid movements. After 23½h. there was depression in V, the minimum appearing shortly after midnight. The element remained depressed until 4h. on October 2. The curves were fairly quiet for the next twenty-four hours, but disturbance began again about 4h. on October 3, and was active when the sheets were changed about 10h. It may be noted here that the storm itself was quite secondary as compared with the big one in August last, and so, from the purely magnetic point of view, the interest is very moderate."

THE SUDAN IRRIGATION WORKS.

IT is an unfortunate circumstance when a controversy respecting the merits of rival schemes for Imperial development works is embittered by charges impugning the good faith of either side, and it is particularly painful when an accusation of this kind is levelled by a Government official of high standing and repute against his colleagues in the Department with which he was formerly associated. We do not propose to discuss the ethical question (it has already been the subject of inquiry by a Foreign Office Committee), but it is unavoidable to mention it as indicating the ground upon which Sir William Willcocks has published his brochure on "The Nile Projects" and the acutely critical spirit in which it is written.

We have already outlined in NATURE for September 18 (p. 67) the schemes actually adopted by their respective Governments, and now in course of execution, for the development of irrigation in Egypt and the Sudan, comprising the formation of a dam on the Blue Nile at Makwar, near Sennar, and of a reservoir at Gebel-el-Auli, on the White Nile; and in the "Notes" columns of the issue for May 22 last (p. 233) we briefly alluded to the alternative proposal advocated by Sir W. Willcocks and designated by him "the Sudd reservoir." The following additional particulars gleaned from the pamphlet before us may be of some interest.

The Blue Nile project, for the irrigation of the Gezirah plain in the Sudan, involves the storage of 463,000,000 cubic metres of water for distribution during the winter season to 300,000 feddâns (acres) about to be exploited in cotton-raising. To meet this requirement a supply of 120–150 cubic metres per second will be necessary at the canal head throughout the winter up to the end of March, although in an occasional year the supply may have to be continued to the middle of April. This would leave three months for the gathering of the crop and the preparation of the ground prior to the next sowing. It is essential to have this period as dry as possible in order to root out the old stalks, which otherwise tend to sprout, as, indeed, happens when the rains supervene. Sir W. Willcocks expresses the apprehension that irrigation supplies will have to be given much later than April 15, and that the sources for Egyptian use will be seriously depleted in consequence.

The White Nile reservoir at Gebel-el-Auli, proposed to be formed by an earthen bank across the river at a point some 50 km. above Khartoum, comes in for the criticism that it will flood a considerable tract of country, disturbing the inhabitants and necessitating their transfer elsewhere, and that the stagnant pools left when the reservoir is low will lead to an increase in mosquitoes. Both these objections were before the Foreign Office Committee, but were not held to be vital. Another point made by Sir W. Willcocks is that a work so remote from Egypt might in the hands of a hostile Power become a serious menace to that country. "An enemy getting possession of the dam and filling it brimful to the height of the earthen bank in a high flood could sweep the Nile Valley as thoroughly as Noah's deluge swept the Euphrates Valley."

Pursuing a trenchant criticism of the estimated cost of the foregoing schemes, Sir W. Willcocks compares them very unfavourably with his own project of utilising as a reservoir the vast tract of swamp known as the Sudd region, where, owing to the dense growth of papyrus and aquatic vegetation, there are "a score of milliards of cubic metres of water standing well above the level of the flat plain as though they were congealed." Such a region, Sir William contends, could be laid under contribution for practically inexhaustible supplies of water more effectively and at less cost.

BRYSSON CUNNINGHAM.

COLLIERY BOILER-PLANTS.

A REPRINT of articles on the performance of colliery steam boiler-plants and the saving to be obtained by their reorganisation, which appeared in *Engineering* for July 25 and August 1 last, has been sent us by the author, Mr. D. Brownlie. The

discussion in the articles is based upon results of tests carried out by the author, and a valuable feature is a large table giving details of these results for 100 boiler plants, chiefly of the Lancashire type. Mr. Brownlie's figures indicate that the average net working efficiency of colliery steam-boiler plants is only about 55·5 per cent. By carrying out a re-organisation of such plants on modern scientific lines it is possible to obtain 70 per cent. efficiency, and Mr. Brownlie estimates that about 6,600,000 tons of coal per annum could be saved by the adoption of scientific methods and by more extensive use of refuse coal.

The 100 boiler plants tested have a total of 570 boilers, 500 of these being Lancashire, 2 Cornish, 37 egg-ended, and 31 modern tubular boilers. The average efficiency of the egg-ended boilers is less than 35 per cent., and there appears to be still a fair number of this type at work, in spite of it being hopelessly out of date. It is also of interest to note that the few modern tubular boilers installed are, on the average, giving no better results than the Lancashire boilers, which average 55 per cent. efficiency. This fact obviously indicates improper arrangements in the installation or bad methods of working, or both.

Another point of importance to which Mr. Brownlie directs attention arises from the Final Report of the Coal Conservation Committee, which states that "the policy of collieries has been to set free the best qualities of coal for the market, and to retain for colliery consumption the poorest quality. The returns show that the quantity of ash in some of the fuels used ranges from 50 per cent. to 80 per cent." Mr. Brownlie actually finds an average of 15·5 per cent. ash and coal of 10,500 B.Th.U. used at colliery boiler plants, and most people will support him in his statements that he has never heard of a case of 50–80 per cent. ash; that such instances must be rare; and that the statement in the report is most misleading. In actual fact, 52 per cent. of the coal employed at collieries is high-grade coal; of the remainder, 32 per cent. could be used economically in industry for steam generation, and only 16 per cent. is definitely unsaleable. The highest ash-content of this refuse coal was 35 per cent. Mr. Brownlie maintains that these results are typical of the colliery industry, and the idea that collieries burn chiefly refuse and unsaleable coal is a complete fallacy.

As a matter of fact, there are millions of tons of refuse coal lying unburnt at collieries, and a very large proportion of this refuse could be utilised for steam generation, as has been proved by Mr. Brownlie's firm on a number of colliery plants. The carrying out of this proposition would result in a very large saving in the coal consumption, even after ample deduction for the cost of extra boilers and plant necessary because of the low calorific value. A fair average price for the whole of the coal burnt on colliery boiler plants is to-day about 20*s*. per ton; making allowance for extra labour, plant, and depreciation, and taking 3 tons of refuse coal as equal in practice to 1 ton of saleable coal, the value of refuse coal to-day would be about 8*s*. per ton.

Mr. Brownlie's pamphlet is to be welcomed, partly on account of the strong case for reform presented in view of the need for national economy, and partly on account of the large number of test results which he gives in a form suitable for easy comparison. The pamphlet may be obtained from Messrs. Brownlie and Green, Ltd., 2 Austin Friars, London, E.C.2.

THE BRITISH ASSOCIATION AT BOURNEMOUTH.

SECTION D.

ZOOLOGY.

OPENING ADDRESS BY DR. F. A. DIXEY, M.A., F.R.S., PRESIDENT OF THE SECTION.

ONE of the results of the great war now happily at an end has been its effect upon science. On the one hand it has checked the progress of scientific investigation; it has done much to destroy international co-operation and sympathy; it has removed from our ranks, temporarily or permanently, many admirable workers. On the other hand it has acted as a great stimulus in many departments of scientific inquiry, and it has given the general public an interest in many scientific questions which have hitherto met with little recognition or encouragement from the people at large. It was perhaps inevitable, but at the same time, as I venture to think, rather to be deplored, that that interest has tended to concentrate itself upon applied more than upon abstract science; that it has been concerned chiefly with the employment of natural knowledge in devising and perfecting new methods of destruction. Terrible as is the power which the present-day engines of warfare have attained, it may be reasonable to hope that some compensation for the mischief and suffering which they have caused may eventually be found in peaceful directions; that the submarine, the aircraft, and even the high explosive may cease to be a terror to civilisation, and in spite of their past history may after all become agents in the advancement of the general welfare:

Hoc paces habuere bonæ, ventique secundi,

will, let us hope, be a legitimate reflection in later times. But for the true scientific worker, I think I may safely assert, the primary object of his studies is the attainment of knowledge for its own sake: applications of such knowledge may be trusted to follow; some beneficial, some perhaps the reverse. Still, whether they do or do not so follow is less a concern of the scientific man than whether his labours have resulted in a fresh advance into the realms of the unknown. I confess to some sympathy with the feeling which is said to be expressed in the regular toast of a certain scientific gathering:—"Pure mathematics, and may they never be of any use to anybody."

For genuine enthusiasm in the cause of science for its own sake, I think that we zoologists may claim a good record. We are by no means unmindful of the great benefits to humanity which have taken their rise more or less directly from zoological science. I need do no more than mention the services to medicine, great at the present and destined to be greater still in the future, that are being rendered by the proto-zoologist and the entomologist. We may look forward also to results of the highest practical importance from the investigations into the laws of heredity in which we are engaged with the co-operation of our allies the botanists. But what we are entitled to protest against is the temper of mind which values science only for the material benefits that may be got from it; and what above all we should like to see is a greater respect on the part of the public for science purely as science, a higher appreciation of the labours of scientific men, and a greater readiness, in matters where science touches on the common affairs of life, to be guided by the accumulated knowledge and experience of those who have made such matters the subject of constant and devoted study. If the war leads to any repair of the general deficiency in these respects, it

will to that extent have conferred a benefit on the community.

Regarding, as I do, my present position in this Section as a great honour and privilege, especially in view of this being the first meeting of the British Association to be held after the war, I hope I may be allowed a few preliminary remarks of a somewhat autobiographical character. As far back as I can remember, zoology has been a passion with me. I was brought up in a non-zoological environment, and for the first few years of my life my only knowledge of the subject was gained from an odd volume of Chambers's "Information for the People." But on being asked by a visitor what I intended to do with myself when I grew up, I can distinctly remember answering, with the confident assurance of seven or eight, "Zoology suits me best"—pronouncing the word, which I had only seen and never heard, as zoology. By the time I went to school, my opportunities had increased; but I soon found myself engaged in the classical and mathematical routine from which in those days there was little chance of escape. In due course I went to the University with a classical scholarship, which necessitated for the time an even more rigid exclusion of scientific aspirations than before. I mention this because I wish to pay a tribute of gratitude to the College authorities of that day, to whose wise policy I owe it that I was eventually able to fulfil in some measure my desire for natural, and especially biological, knowledge. After two years of more or less successful application to the literary studies of the University, I petitioned to be allowed to read for the final school in natural science. The petition was granted; my scholarship was not taken away, and was even prolonged to the end of my fifth year. This I think was an enlightened measure, remarkable for the time, more than forty years ago, when it was adopted. I only hope that we have not in this respect fallen back from the standard of our predecessors. The avidity with which I took up the study of elementary chemistry and physics, and the enthusiasm with which I started on comparative anatomy under the auspices of George Rolleston are among the most pleasant recollections of my youth. But from the force of circumstances, though always at heart a zoologist, I have never been in a position to give myself unreservedly to that department of biology; and even now, in what I must call my old age, I fear I cannot regard myself as much more than a zoological amateur. My working hours are largely taken up with serving tables.

What moral do I draw from this brief recital? Not by any means that I should have been allowed to escape a grounding in the elements of a literary education, though I think it quite possible that the past, and even the present, methods of school instruction are not ideally the best. My experience has led me to conclude that much of the time spent over the minutiæ of Greek and Latin grammar might, in the case of the average boy, be better employed. But I do not agree that a moderate knowledge of the classics, well taught by a sensible master, is useless from any reasonable point of view. To those of my hearers who appreciate Kipling, I would call to mind the vividly truthful sketch of school life called "Regulus." Let them reflect how the wonderful workmanship of the inspired and inspiring Ode of Horace, round which the sketch is written, must have sunk into the mind of the apparently careless and exasperating "Beetle," the "egregious Beetle" as King calls him, to bear such marvellous fruit in after years. Beetle, as we all know, is no professional scholar, no classical pedant, but a man of the world who has not forgotten his Horace, and upon whose extraordinary literary skill those early school-tasks must have had, whether consciously or not, a dominating influence. How else could he have written "Regulus"? "You see," says King, "that some of it sticks." So it does, if it is only given a fair chance; and in the skirmish between King the classical and Hartopp the science master, both right up to a point and both wrong beyond it, I give on the whole the palm to King. To revert to my own case. I do not regret a word of either the Latin or the Greek that I was obliged to read, nor even the inkling of the niceties of scholarship to which I got, I hope, a fair introduction. But I do think that I might have been allowed to start on scientific work at an earlier period, and that a good deal of the time spent, say, on Greek and Latin prose and verse writing, might in my case have been well spared for other objects.

To generalise what I have been saying. Start teaching your boy or girl on a good wide basis. Nothing is better for this than the old school subjects of classics, history, and mathematics, with the addition of natural science. In course of time a bent will declare itself. Encourage this, even at the expense of other studies desirable in themselves. But do not allow any one subject, however congenial, to usurp the place of a grounding in those matters which are proper to a general education. The time for specialising will come; and when it has arrived do all you can to remove obstacles, pecuniary and other. Do not hamper your historian with chemistry or your zoologist with the differential calculus. If they have a taste for these things by way of diversion or recreation, well and good. But let their action be voluntary.

This, however, is not a fitting occasion for propounding my views on the question of education, and it is time to turn to the immediate object of my address. And here I think I cannot do better than bring before your notice certain facts which have a bearing on the subject of insect mimicry; a subject which for many years past has engaged much of my attention. The facts on all hands are allowed to be remarkable. As to their interpretation there is much diversity of opinion; and indeed, until complete data are forthcoming, this could scarcely be otherwise.

In the first place let us glance at a certain assemblage of butterflies that inhabits New Guinea with some of the adjacent islands. These butterflies, though belonging to different subfamilies, present a resemblance to each other which is too strong to be accidental. Three of them belong to the Pierines, the group which includes the common white butterflies of this country; the fourth is a Nymphaline, not widely removed from our well-known tortoiseshells, red admiral and peacock. The resemblance on the upper surface between two of the three Pierines is not especially noteworthy, inasmuch as they present in common the ordinary Pierine appearance of a white or nearly white ground colour with a dark border somewhat broadened at the apex. But this, an everyday feature in the Pierines, is almost unknown in the very large subfamily to which our present Nymphaline belongs. Still, though sufficiently remarkable to arrest the attention of anyone familiar with these groups, the Pierine-like aspect of the upper surface of this Nymphaline, which is known as *Mynes doryca*, would not by itself have seemed to call for any special explanation. The resemblance would pass as merely an interesting coincidence. But the under surface of the three Pierines, known respectively as *Huphina abnormis*, *Delias ornytion*, and *Delias irma*, presents a striking combination of colour very unusual in their own group; and this peculiar character of the under surface is shared by the Nymphaline *Mynes doryca*. The "long arm of coincidence" could scarcely reach so far as this. Whatever might be said about the likeness seen from above, that the wings beneath should show

virtually the same unusual pattern in the Mynes as in the Pierines seems to call for some explanation other than an appeal to chance or accident. Moreover, with regard to the Pierines themselves, the two members of the genus Delias are, of course, fairly closely related; but the Huphina belongs to an entirely distinct genus, separated from Delias by many important structural differences. The two species of Delias perhaps depart less widely in aspect from their nearest congeners than does either the Huphina or the Mynes. The under surface of the Huphina is unexampled in its genus, but the upper surface is quite ordinary. The Mynes, as we have seen, stands alone among its nearest relatives not only in the character of its under surface, but also in the Pierine-like character of its wings above.

We will now turn to another assemblage, which presents us with the same problem from a somewhat different point of view. In south-eastern Asia, with certain of the adjacent islands, is found a genus of large butterflies, called by Wallace Prioneris from the saw-like front margin of the forewing in the male. More than fifty years ago it was remarked by Wallace that the species of Prioneris in several cases seem to mimic those of the genus Delias, and that "in all cases the pairs which resemble each other inhabit the same district, and very often are known to come from the same locality." The parallelism is even stronger than was stated by Wallace, for there is not a single known member of the genus Prioneris which does not resemble a species of Delias, so that Prioneris cannot really be said to have an aspect of its own. *Prioneris clemanthe* and *Delias agostina* form a pair inhabiting the Himalayas, Burma, and Further India. In the same region occur *Prioneris thestylis* and *Delias belladonna*, the striking similarity of which species, especially on the underside and in the female, drew the special attention of Mr. Wallace. A still more remarkable instance is that of *Prioneris sita* of southern India and Ceylon, the likeness of which to the common Indian *Delias eucharis* is spoken of by Wallace as "perfect"; while Fruhstorfer, a hostile witness, testifies to the fact that the Prioneris always flies in company with the Delias, and rests just like the latter with closed wings on the red flowers of the Lantana. *Prioneris hypsipyle* of Sumatra and *P. autothisbe* of Java are like *Delias egialea* and *D. crithoe* of the same two islands. Here again Fruhstorfer says of *Prioneris autothisbe* that it visits the flowers of the Cinchona, "always in company with the similarly coloured *Delias crithoe*." Wallace remarked on the close similarity between *Prioneris cornelia* of Borneo and *Delias singhapura* of the Malay Peninsula; in this case, it will be noted, the localities, though not far distant from each other, are not identical. But a Delias form which was unknown at the date of Wallace's paper has since been found in Borneo, and this latter butterfly, known as *D. indistincta*, is even more exactly copied by *P. cornelia* than is the *Delias* which first drew Wallace's attention. *Prioneris vollenhovii* of Borneo is a kind of compromise between *Delias indistincta* and, on the underside, *D. pandemia* of the same island, and it may be added that another Bornean Pierine, *Huphina pactolica*, is a good copy of *Delias indistincta*, therefore resembling also the Bornean *Prioneris cornelia* and *P. vollenhovii*.

The memoir, published in 1867, in which Wallace remarked on the parallelism between Prioneris and Delias, contains a noteworthy prediction by the same author. Speaking of *Pieris* (now called *Huphina*) *laeta* of Timor, he says that it "departs so much from the style of colouring of its allies and approaches so nearly to that of *Thyca* (*Delias*) *belisama* of Java, that I should almost look for an ally of the last species to be discovered in Timor to serve as its pattern." Thirty-four years after the expression of this anticipation, Mr. Doherty discovered in Timor an ally of *Delias belisama* which at once suggests itself as the model from which the peculiar and brilliant colouring of *Huphina laeta* has been derived. Fruhstorfer, who is by no means friendly to the theory of mimicry, says of this Delias, which was named splendida by Lord Rothschild, that beneath it is "deceptively like *Huphina laeta*." But here comes in a curious point. The black forewing with its yellow apex and the orange-yellow hindwing with its scarlet black-bordered costal streak are present on the underside of both the Delias and the Huphina; but the latter butterfly possesses, in addition to these features, a row of scarlet marginal spots on the hindwing which are not to be found on the Delias. In spite of this discrepancy, the likeness is sufficiently striking. But from the same island of Timor, Doherty sent home another Delias which, besides resembling *D. splendida*, possesses a row of scarlet patches in the corresponding situation to those of *H. laeta*. In this latter Delias, however, named *dohertyi* by Lord Rothschild after its discoverer, the brilliant scarlet costal streak is completely absent. The Huphina, therefore, is more like either species of Delias than they are like each other, forming, as it were, a link between them. So that, adopting Professor Poulton's terminology, we may say that, if this is a case of mimicry, one form may possess at the same time the aposemes belonging to two distinct models. I will not now stop to discuss the bearing of this case on current theories, but will only remark that, granting mimicry, the whole assemblage, *D. splendida*, *H. laeta*, *D. dohertyi*, may be expected to gain advantage from the blending action of the intermediate *H. laeta*. This I think would happen whether *laeta* is a "Batesian" or "Müllerian" mimic, but the gain to the association in the latter case is certainly the more obvious.

This state of things would be sufficiently curious if it stood by itself. But it does not stand by itself. In Lombok, Sumbawa, and Flores there occurs another member of the peculiar group of Huphina to which *H. laeta* belongs. This butterfly, known as *H. temena*, resembles *H. laeta* in many respects; possessing on the underside of the hindwing a scarlet costal streak and a row of scarlet marginal spots like those of that insect. The forewing, however, differs from that of *H. laeta* in having its ground-colour not uniformly black, but divided between a dark shading to the veins, a dark submarginal band, and series of pale streaks and patches in the interspaces between the veins. The question at once suggests itself: Is there a relation between *H. temena* and one or more species of Delias corresponding to that between *H. laeta* and *D. splendida* and *dohertyi*? The answer to this question is in the affirmative. *Delias oraia*, together with *Delias sumbawana*, both species inhabiting the same three islands as *H. temena*, form with it an assemblage quite comparable with the former triad from Timor. Further, the points in which *H. temena* differs from *H. laeta* have their counterpart in the distinctions between *D. oraia* and *D. splendida* on the one hand, and *D. sumbawana* and *D. dohertyi* on the other. These points are chiefly, in the *temena* assemblage, the less definitely black-bordered costal streak, the more strongly-marked black bordering to the submarginal scarlet spots, and the diversely-coloured as compared with the uniformly black forewing of the Timor insects.

Again, in the island of Bali, *Huphina tamar* would seem to combine certain features of two species of Delias in a similar manner to the cases of *laeta* and *temena* just considered. The underside as a whole is reminiscent of *D. periboea*, a member, like *D. dohertyi* and *D. sumbawana*, of the eucharis or hypa-

rete group of the genus; while the red costal streak suggests the influence of a representative in Bali of the belisama group, like *D. splendida* and *D. oraia* in the other islands.

Finally, in the island of Sumba we have another member of this remarkable group of Huphinas. *Huphina julia,* the butterfly referred to, so closely resembles *Delias fasciata* of the same island, that even the sceptical Fruhstorfer is constrained to speak of it as a "faithful copy" of that insect. But here once more it is noticeable that one of the most conspicuous features of the Huphina is absent from the Delias. This time it is not, as in the case of *D. splendida,* the submarginal row of scarlet spots on the underside of the hindwing, but it is the scarlet costal streak that is wanting. *Huphina julia* was discovered by Mr. Doherty in the year 1887, and described in 1891. It is interesting, in the light of what is now known of the butterfly fauna of the Lesser Sunda islands, to read what Doherty has to say about the mimicry question in relation to the Delias and Huphina forms that have just been mentioned. Speaking of *H. julia,* he says, "If it stood alone, I should certainly suppose it to be a mimic of some form of *Delias hyparete* yet undiscovered in the island. But both *H. laeta* and *H. temena* require to be accounted for in the same way, and while it is possible that some Timorese Delias may resemble *H. laeta,* I feel sure that *H. temena* can have no such original. It must then be assumed that this group is less pressed by its enemies in the Timorian Islands, and has therefore been able to acquire more brilliant colours than its allies." So far Doherty.

Whatever may be the value of this last hypothesis, we have just seen that the supposed facts on which it rests are non-existent, for (1) the "form of *Delias hyparete* as yet undiscovered" has actually turned up in the person of *D. fasciata*; (2) it is not only possible, but actually the case, that "some Timorese Delias may resemble *H. laeta*"; (3) Mr. Doherty "feels sure that *H. temena* can have no such original," but *Delias oraia* and *Delias sumbawana* have just the same relation to *Huphina temena* as *D. splendida* and *D. dohertyi* to *H. laeta.* In view of these facts it may be not rash to suppose that the apparent absence of a model for the red costal streak of *H. julia* may hereafter be accounted for.

Of the three instances of possible mimetic association which have now been mentioned, I think that only one, viz. the first, has previously been treated in detail. The numbers of cases more or less similar to these three might be very largely extended, but for our present purpose it will be sufficient to confine our attention to those already given. It is probable that to some minds the facts adduced are simply curious coincidences, needing no explanation; but it can scarcely be wrong to suppose that to most students of nature the observed phenomena do call for some attempt at interpretation; and on a review of the evidence it seems clear that the geographical element must enter largely into any explanation that may be offered. On the whole, it is certainly the case that the forms which are supposed to be related by mimicry do inhabit the same localities; the continental Prioneris, for example, is like the continental Delias, and the island Prioneris recalls the island, not the continental, Delias. Moreover, we find the differences between the Delias of Timor, of Sumbawa and Sumba reflected in the associated Huphinas of the same islands. If it be granted that the geographical element is a factor, it is natural to inquire how it works.

It is no doubt true that external geographical conditions are occasionally capable of producing, whether directly or indirectly, a community of aspect in the animals or plants exposed to their influence. The prevalence of a sandy coloration in the mammals and birds of a desert, and of whiteness in the inhabitants of the arctic snow-fields, the spiny character so often assumed by the plants of arid regions, and the general dwarfing of the vegetation that grows close to the sea, may be given in illustration. At first sight these phenomena may seem to be of the nature of direct effects of the environment; quite possibly some of them are so, but I think few observers would deny that they are at least largely adaptive, being used for purposes of aggression or defence. Still, even if we allow the direct effect of the environment, as perhaps we may do especially in the case of the plants, can we frame any hypothesis of the action of geographical conditions which shall lead directly to the assumption of a common pattern in the case of the three or four butterflies from New Guinea? I confess that I am quite unable to do so. If the climate, or the soil, or any other geographical condition in New Guinea is capable of directly inducing so remarkable a combination of colour as we see in these Pierines and Nymphalines, why does it not affect other organisms in a similar way? Why do not other Pierines, for instance, closely related to ornytion and abnormis, share in the same coloration? And considering the characteristic aspect of the underside, which is supposed to be called into being by some unexplained condition peculiar to New Guinea, we may well ask, Why should its most conspicuous features belong in the one case to the forewing and in the other to the hindwing, and *vice versa,* the general effect being the same?

Fruhstorfer, we may note, does not feel these difficulties. "Many Pierids," he says, "present typical examples of that resemblance to other butterflies which has been named mimicry. The origin of this resemblance, however, is now explained by the supposition that the mimics were modified by the same (as yet unknown) influences under which the colouring of the models, mostly Danaids, developed." I think it will be generally agreed that this reference to "unknown influences" is no explanation at all.

It is necessary to take into account the fact that the resemblances of which we are speaking are independent of structural differences, being, in fact, merely superficial. This is a point which is capable of much wider demonstration than I am giving it to-day. But even from the instances now before us I think there cannot be much difficulty in coming to the conclusion that the resemblances are an appeal to vision. They are meant to be *seen,* though by whom and for what purpose may be open to question. Speculations as to recognition and sexual attraction may, I think, in these cases be put out of court; but there remains the theory of warning colours assumed in reference to the attacks of vertebrate enemies. From the fact that the most striking and most conspicuous of these common aposemes or danger-signals belong to the under surface—that is to say, the part chiefly exposed to view during rest—it may be inferred that the enemies to be guarded against are mainly those that attack butterflies, not on the wing, but when settled in repose. Both birds and monkeys are known to feed on butterflies, and there is a good deal of evidence as to their preference for one kind of food over another. I will not stop to give details, but anyone who wishes to study the evidence may be referred especially to the memoirs of Dr. G. A. K. Marshall, Mr. C. F. M. Swynnerton, and Capt. G. D. H. Carpenter.

If the warning-colour interpretation of these resemblances be the true one, we see at once why they are so largely independent of structure and affinity. Being meant to catch the eye, they ride rough-shod, so to speak, over inconspicuous features, such as venation; nor do they respect more than the nature of things

obliges them to do the ties of blood-relationship. Then, again, it is obvious why they occur in the same and not in widely different localities; in some instances, as we have seen, their bearers actually flying in company and frequenting the same flowers; for the common aspect, supposing it to be in any sense protective, would only take effect when the sharers in it were exposed to the attacks of the same body of enemies; that is to say, when they inhabited the same locality. And this would be equally true, whether the warning colours are shared between distasteful forms, or whether they are deceptively adopted by forms unprotected by inedibility; whether, in Prof. Poulton's terms, they are synaposematic or pseudaposematic. I do not enlarge upon this part of the question, or upon the theories which are known under the names of Bates and Müller respectively, because these theories have been fully dealt with elsewhere, and I think I may assume that they are familiar to the greater part of my hearers. But that mistaken ideas as to what is really meant by protection and mimicry still prevail in some quarters, is evident from certain remarks of Fruhstorfer in dealing with the genus Prioneris which we have just been discussing. "Wallace," he says, "regards the 'rarer' Prioneris as a mimetic form of the 'commoner' Delias. But I cannot accept his view, since mimicry among the in all respects harmless Pierids appears no sort of protection, and, properly speaking, the smooth-margined Delias should rather copy the armed Prioneris if there is assumed to be mimicry at all." If anyone has no better knowledge than this of what is meant by the theory of mimicry, it is not wonderful that he should consider the subject unworthy of serious attention.

The warning-colour theory, then, gives a rational explanation both of the superficial character of the resemblances and of the geographical factor in their occurrence. But it obviously involves the reality of natural selection; and it is here that some are disposed to part company with the upholders of the theory. I have already referred to the fact that much positive evidence now exists both that butterflies are eaten and that preferences on the part of their enemies exist between one kind and another. I will only remark in passing that the objector on this score sometimes adopts an attitude which is scarcely reasonable, and, perhaps, on that very account is somewhat hard to combat. The kind of objector that I mean begins by saying that the destruction of butterflies by birds and other enemies is not sufficient to give play for the operation of selection. You beg his pardon, and produce evidence of considerable butterfly destruction. To which he replies, "Oh, they *are* eaten, are they? I thought you said they were protected." This is a good dilemma, but the dilemma is notoriously an unconvincing form of argument. If a reply be called for, it may be given like this: "Butterflies are either preyed upon or they are not. If they are, an opening is given for selection; if they are not, it shows the existence of some form of protection." The essence of the matter is that both the likes and dislikes of insectivorous animals, and the means of protection enjoyed by their prey, are not absolute, but relative. A bird that will reject an insect in some circumstances will capture it in some others; it will, for instance, avoid insect A if it can get insect B, but will feed on A if nothing else is to be had; and it is probable that scarcely any insect is entirely proof against the attack of every kind of enemy. The relative nature of protection is readily admitted when the question is not one of mimicry or of warning colours, but of protective resemblance to inanimate objects. All degrees of disguise, from the rudimentary to the almost perfect, are employed; the lower degrees are allowed to be of some service, and, on the other hand, a disguise that is almost completely deceptive may at times be penetrated. This consideration applies also to the objection that the first beginnings of mimetic assimilation can have no selective value. If the rough resemblance to an inanimate object affords some amount of protection, though that amount may be relatively small, why should not the same apply to the first suggestion on the part of a mimic of an approach to the aposeme or warning colour of its model? The position that neither kind of assimilation is of service is intelligible, though not common; but there is no reason why benefit should be affirmed in the one case and denied in the other. There are further considerations which tend to deprive this latter criticism of force; the fact, for instance, that a resemblance to one form may serve as a stepping-stone for a likeness to another; or, again, the existence of clusters, as they may be called, of forms varying in affinity, but embodying a transition by easy stages from one extreme to another. In a case of this sort the objection that may be felt as to two terms in the series arbitrarily or accidentally picked out is seen to be groundless when the whole assemblage is taken together.

Much attention has lately been given to the fact that of individual variations some are transmissible by heredity and some are not; under the latter heading would generally fall somatic modifications directly induced upon the individual by conditions of environment. Whether any other kind of variation belongs to the same category need not for the present purpose come into discussion. But with regard to the undoubtedly transmissible variations, or mutations if we like to call them so, there is, I think, a fairly general consensus of opinion that they need not necessarily be large in amount. A complete gradation, in fact, appears to exist between a departure from type so slight as to be scarcely noticeable, and one so striking as to rank as a sport or a monstrosity. And we know now that where the Mendelian relation exists between two forms, no amount of interbreeding will abolish either type; intermediates, when formed, are not permanent, and if one type is to prevail over the other, it must be by means of selection, either natural or artificial.

In view of all these considerations, I venture to think that there is no reason to dispute the influence of natural selection in the production of these remarkable resemblances. Other interpretations may no doubt be given, but they involve the ignoring of some one or more of the facts. It may fairly be claimed that the theories of Wallace, Bates, and Müller, depending as they do on a basis of both observation and experiment, come nearer to accounting for the facts than any other explanation yet offered. It will, of course, always be possible to deny that any explanation is attainable, or to assert that we ought to be satisfied with the facts as we find them without attempting to unravel their causes. But such an attitude of mind is not scientific, and if carried into other matters would tend to deprive the study of Nature of what, to most of us, is its principal charm. It is quite true that before the validity of any generalisation is accepted as finally and absolutely established, every opportunity should be taken of deductive verification. This has been fully recognised by the supporters of the theory of mimicry, and much has been done to test in this manner the various conclusions on which the theory rests. The verification is not complete, and perhaps never will

be, but every successive step increases the probability of its truth; and probability, as Bishop Butler taught, is the guide of life. Meantime it is, one may say, the positive duty of everyone who has the opportunity, to fill up, so far as is in his power, the gaps that still exist in the chain of evidence. Here is an especially promising field for naturalists resident in tropical regions.

Before concluding this address there are two points on which I should like to lay some special emphasis. One is the undesirability—I had almost said folly—of undervaluing any source of information or any particular department of study which does not come within the personal purview of the critic or commentator. "I hold," says Quiller-Couch, "there is no surer sign of intellectual ill-breeding than to speak, even to feel, slightingly of any knowledge oneself does not happen to possess." This is a temptation to which many of us are liable; and falls, I fear, are frequent. It was a matter of sincere regret to me to find one of my most valued scientific friends speaking publicly of the Odes of Horace as a subject comparatively devoid of interest. I can only confess my utter inability to sympathise with my friend's point of view. If he had merely said, "Excellent as those works may be, I have other things to do than to attend to them," I could approve; but that is a different matter. The failing that I speak of is, unfortunately, by no means unknown among scientific men, and is perhaps rather specially prevalent when such subjects as those of my present address are in question. I can recall a very eminent man of science, no longer living, speaking with scarcely veiled scorn of those who occupied themselves with "butterflies in cases." This was in a presidential address to a section of this association. If so little respect is paid by a leader of science to work done in another part of the field, it is perhaps not to be wondered at that one of his Majesty's judges should speak of the formation of a great collection of butterflies—a most valuable asset for bionomic research—as the "gratification of an infantile taste." This or that collector may be an unscientific person, but it would be easy to show that the study of insects in general, and of butterflies in particular, is one of the most efficient of the instruments in our hands for arriving at a solution of fundamental problems in biology.

My second and final point is this: I have not hesitated to affirm my conviction of the importance in evolution of the Darwinian doctrine of natural selection. This necessarily carries with it a belief in the existence and general prevalence of adaptation. I am willing to admit that at times too much exuberance may have been shown in the pursuit of what Aubrey Moore called "the new teleology." "Men of science," it has been said, "like young colts in a fresh pasture, are apt to be exhilarated on being turned into a new field of inquiry; to go off at a hand-gallop, in total disregard of hedges and ditches, to lose sight of the real limitation of their inquiries, and to forget the extreme imperfection of what is really known." This is not the utterance of some cold outside critic, but of a great exponent of scientific method—no other than Huxley himself. It may be true of some of the wilder speculations of Huxley's date. I am by no means sure that there is not truth in it as applied to some of the developments of a later time. But however wide of the mark our suggested explanations and hypotheses may be, the net result of all our inquiries, after the gradual pruning away of excrescences and superfluities, will be a real advance into the realms of the unknown. We may feel perfectly assured that the objections so far brought against our own interpretations are null and void, but we may yet have to give way in the light of further knowledge. "Let us not smile too soon at the pranks of Puck among the critics; it is more prudent to move apart and feel gently whether that sleek nose with fair large ears may not have been slipped upon our own shoulders."[1]

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

BRISTOL.—Under the will of the late Dr. Joseph Wiglesworth, whose interest in bird life is widely known, his ornithological library passes by bequest to the University. This library of more than 1000 volumes, including finely-bound copies of the works of Gould, Seebohm, Dresser, Lilford, Levaillant, and other leading authorities, is probably one of the best in the kingdom. It will be housed in a separate room in the new University buildings, and will be kept up to date. Dr. Wiglesworth gave the residue of his estate to the University after his widow's death for the furnishing and maintenance of this special library. The advantage to a university of facilities for prosecuting specific lines of research can scarcely be overestimated. Situate, as is Bristol, in a district rich in birds, it is to be hoped that the studies to which Dr. Wiglesworth devoted so large a portion of the little leisure obtainable in a busy and fruitful life will be stimulated by a bequest which will serve to keep his own work in remembrance.

CAMBRIDGE.—Dr. A. E. Shipley, Master of Christ's College, has resigned the office of Vice-Chancellor and been succeeded by Dr. Peter Giles, Master of Emmanuel. During his period of office Dr. Shipley devoted himself consistently to progressive measures, and was most active in furthering schemes of scientific importance. He has had two years of very strenuous work under abnormal conditions, and members of the University are grateful to him for the devoted attention he has given to all matters affecting their best interests.

GLASGOW.—During the summer an unusually large number of university lecturers have been promoted to professorial chairs at Glasgow and elsewhere. Prof. Henderson, formerly assistant, and lately professor, at the affiliated Royal Technical College, has been appointed to the Regius chair of chemistry in the University; Dr. T. S. Patterson, Waltonian lecturer, to the Gardiner chair of organic chemistry; Dr. E. P. Cathcart, formerly Grieve lecturer, to the Gardiner chair of physiological chemistry; Dr. C. Browning, formerly lecturer in clinical pathology, to the Gardiner chair of bacteriology; and two other lecturers in the arts faculty have also been promoted to chairs in the University.

The Queen's University of Belfast has elected Dr. A. W. Stewart, lecturer in physical chemistry at Glasgow, to its chair of chemistry, and Dr. T. Walmsley, lecturer in embryology at Glasgow, to its chair of anatomy. Dundee University College (St. Andrews) has appointed Dr. F. J. Charteris, lecturer in pharmacy at Glasgow, to its chair of materia medica, and Dr. J. F. Gemmill, research fellow and formerly lecturer in embryology at Glasgow, to its chair of natural history. Dr. Shaw Dunn, lecturer in clinical pathology at Glasgow, has been appointed professor of pathology in the University of Birmingham. Dr. W. E. Agar, lecturer in zoology and heredity at Glasgow, has been appointed professor of biology in the University of Melbourne. Dr. Leonard Findlay, Gow lecturer in medical diseases of children, has also been

[1] Dowden.

appointed Director of Child Welfare to the International Red Cross organisation at Geneva. Three lecturers in the departments of economics, history, and modern languages have received professorial appointments in other universities.

LONDON.—A course of lectures on "A General Survey of the Globe and its Atmosphere," with practical work, will be given at the Meteorological Office, South Kensington, by Sir Napier Shaw, reader in meteorology in the University, on Fridays at 3 p.m. during the second term, beginning on January 23 next. The informal meetings at the Meteorological Office for the discussion of important contributions to current meteorology in Colonial or foreign journals will be resumed at 5 p.m. on Monday, November 3, 1919, and will be continued on alternate Mondays until March 22, 1920, with the exception of December 29. Students wishing to attend should communicate with the Reader at the Meteorological Office. The lectures are addressed to advanced students of the University and to others interested in the subject. Admission is free by ticket, obtainable on application at the Meteorological Office.

The academic teaching of military science as a subject of curricula for degrees of the University is to be resumed in the session now opening. Some years before the war military science was introduced as an optional subject for the Intermediate and Final Courses for the B.A. and B.Sc. degrees. The syllabuses have recently been revised by the Senate in the light of experience gained during the war, and it is expected that, in view of the large number of students who have gained practical military experience during the war, the subject will attract an increased number of students. The subject can be studied in the University both as a branch of general education and, in the case of candidates for University commissions in the Regular Army, as a preparation for their profession. Both classes of student will be able to obtain practical military training in the University Contingent of the Officers Training Corps. The post-war conditions under which commissions in the Regular Army may be obtained by University candidates have not yet been published.

SHEFFIELD.—Prof. J. O. Arnold, who recently resigned his position as professor of metallurgy and dean of the faculty of metallurgy in the University of Sheffield, has been in failing health for some time, and, much to the regret of the University authorities, he has found himself unable to continue his work. Prof. Arnold was appointed in 1889 professor of metallurgy in succession to the late Prof. W. H. Greenwood at the technical department of the Firth College, which afterwards became a constituent part of University College, Sheffield, and later of the University of Sheffield. The applied science department of the University has kept pace with the applications of science to the steel industry, and taken a prominent part not only in the supply of trained men to these industries, but also in producing in rapid succession a number of valued contributions to the science of metallurgy. Prof. Arnold himself has been an active contributor for many years of valuable papers and researches carried out in the laboratories of his department. In 1912 he was elected a fellow of the Royal Society, and in 1916 a member of the council of the Iron and Steel Institute. He lectured before the British Association during its visit to South Africa in 1905, and he became the first dean of the faculty of metallurgy recently established in the University. His colleagues and friends wish him renewed health and vigour, which they trust may come to him now that he has allowed himself to relinquish some of the strenuous duties which he has performed so successfully for many years.

DR. EDWARD HINDLE, Kingsley lecturer and Bye fellow of Magdalene College, Cambridge, and assistant to the Quick professor of biology, has been elected to the chair of biology in the School of Medicine, Cairo, Egypt.

DR. R. H. A. PLIMMER, reader in physiological chemistry, University College, London, has been appointed as head of the biochemical department of Craibstone Animal Nutrition Research Institute, which is under the direction of Aberdeen University and the North of Scotland College of Agriculture.

MR. J. R. TAYLOR has been appointed to the newly-created post of director of humanistic studies in the Huddersfield Technical College. Mr. Taylor is a graduate of the University of Edinburgh, and for several years past has occupied the position of lecturer to University tutorial classes under the University of Leeds.

NEWS has just reached us of munificent bequests made to educational institutions in the Commonwealth of Australia by the late Sir Samuel McCaughey. Bequests made to the Sydney University, the Brisbane University, soldiers and their dependents, and the Presbyterian Church in New South Wales and Queensland are proportions of the residue of the estate, and the amounts are, therefore, contingent upon the sum realised by the estate. The estimated value of the estate is 1,750,000*l.*, and it is believed that, after certain legacies, amounting to about 230,000*l.*, and the other specific bequests are provided for, the residue of the estate will amount to 1,394,000*l.* Among the specific and the residuary bequests based on this estimate for educational, religious, and charitable purposes, the following are mentioned in the *Sydney Morning Herald*:—Sydney University, 465,000*l.*; Brisbane University, 232,000*l.*; Scots College, Sydney, 20,000*l.*; Sydney Grammar School, 10,000*l.*; North Sydney Church of England Grammar School, 10,000*l.*; Cranbrook Church of England Grammar School, 10,000*l.*; Newington College, 10,000*l.*; and King's School, Parramatta, 10,000*l.* The university bequests are unconditional. The gift to the University of Queensland (Brisbane) will enable that institution to do what it has always wanted to do, and never had the chance of doing: become a university, and more than a place for imparting a certain amount of (chiefly) technical instruction. The political world is rather a troubled one, and the type of Labour Party in power has not taken much interest in higher education. So the University has been cramped for funds, and unable to get much past its initial stage. With the gift to Sydney it is hoped that in a few years' time this institution will be a far bigger force for good than it now is. State education policy has brought secondary education to the people, with the natural result that the University is thronged, and that the buildings have been taxed to the limit of their capacity, the staff, especially on the scientific side, being far too heavily burdened. Now there is a prospect of an end to that condition of affairs, and, as the State will doubtless add to the buildings, the new revenues can go to strengthen the staff and bring in a number of leading men. A great increase in the graduate travelling scholarships is also desired, so that more of the best men of the University may spend some years in England and elsewhere. It is hoped that Cambridge will soon allow a Sydney B.Sc. to enter for the Tripos without making him pass the Little-go.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, September 15.—M. Léon Guignard in the chair.—E. **Goursat**: Remarks on a problem of vectorial geometry.—H. **Le Chatelier** and B. **Bogitch**: Refractory properties of aluminous materials. In spite of the high melting point of alumina, it has proved in practice to be an unsatisfactory refractory material. Measurements of the resistance to crushing at varying temperatures of alumina bricks, made up in different ways, are given, and it is shown that all become plastic at temperatures between 1200° C. and 1500° C. This explains their failure in steel furnaces, where the temperature exceeds 1600° C. In special types of laboratory furnace, where the material is not required to bear pressure, alumina can be used with advantage, and details are given of the method of building such a furnace capable of sustaining a temperature of 1600° C.—H. **Le Chatelier**: The development of scientific research in the United States.—A. **Foch**: Concerning the period of water-mains with a unique characteristic, furnished with an air-chamber.—L. **Picart** and F. **Courty**: Observations of the Metcalf and Borrelly comets made at the Bordeaux Observatory (38-cm. equatorial). Details of observations made on August 23 (Metcalf), August 31, and September 1 and 4 (Borrelly).—L. **Picart** and F. **Courty**: Further observations on these two comets. Measurements are given for September 5, 9, 10, and 11.—H. **Vanderlinden**: Elements of the comet 1919*c* (Borrelly).—L. **Guillet**, J. **Durand**, and J. **Galibourg**: Contribution to the study of the tempering of certain aluminium alloys. The alloys studied were of the duralumin type, containing about 3·7 per cent. of copper, 0·6 per cent. of manganese, 0·25 per cent. of zinc, and 0·43 per cent. of magnesium. The breaking strain, elastic limit, and hardness all increase with the time after tempering, a remarkable property shown by this alloy alone. The hardness was measured at varying intervals of time after tempering at temperatures of 300° C., 400° C., 450° C., and 500° C., and the transformation point found to lie between 400° C. and 450° C. The increase of hardness with time was only shown when the tempering temperature was above 400° C.—A. **Carpentier**: The fructifications of *Sphenopteris herbacea*.—L. **Daniel**: The stability and heredity of the Cratægomespilus and the Pirocydonia.—V. **Galippe**: The resistance of living intra-cellular agents to the action of certain chemical substances. The microzymas of tissues are not destoyed by glycerol, alcohol, chloroform, or by lapse of time.—M. **Herlant**: New researches on the inhibiting action exercised by the sperm of the mollusc on the fecundation of the egg of the sea-urchin.

BOOKS RECEIVED.

Cattle and the Future of Beef-Production in England. By K. J. J. Mackenzie. Pp. xi+168. (Cambridge: At the University Press.) 7*s.* 6*d.* net.

Unexplored New Guinea. By W. N. Beaver. Pp. 320. (London: Seeley, Service, and Co., Ltd.) 25*s.* net.

Spitsbergen. By Dr. R. N. Rudmose Brown. Pp. 319. (London: Seeley, Service, and Co., Ltd.) 25*s.* net.

Modern Engineering Workshop Practice. By H. Thompson. Pp. xi+328. (London: C. Griffin and Co., Ltd.) 9*s.* net.

Catalysis in Theory and Practice. By Dr. E. K. Rideal and Prof. H. S. Taylor. Pp. xv+496. (London: Macmillan and Co., Ltd.) 17*s.* net.

Submarines and Sea Power. By C. Domville-Fife. Pp. viii+250. (London: G. Bell and Sons, Ltd.) 10*s.* 6*d.* net.

An Introduction to General Physiology, with Practical Exercises. By Prof. W. M. Bayliss. Pp. xv+238. (London: Longmans and Co.) 7*s.* 6*d.* net.

Text-book on Wireless Telegraphy. By Prof. R. Stanley. New edition in 2 vols. Vol. i. Pp. xiii+471. Vol. ii. Pp. ix+357. (London: Longmans and Co.) 15*s.* net each vol.

A Practical Handbook of British Birds. Part 4. Pp. 209–272+3 plates. (London: Witherby and Co., September 26, 1919.) 4*s.* net.

DIARY OF SOCIETIES.

TUESDAY, OCTOBER 14.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8 15.—Lieut. E. W. Pearson Chinnery: Initiation Ceremonies of the Mambare and Kumusi Divisions, British New Guinea.

THURSDAY, OCTOBER 16.

THE INSTITUTION OF MINING AND METALLURGY, at 5.30.—C. M. Harris: Prospecting for Gold and Other Ores in Western Australia.—F. Danvers Power: Coral Island Phosphates in the Making.

OPTICAL SOCIETY, at 7.30.—J. W. French: The Unaided Eye, II.—Chas. W. Gamble: Projection Screens.

TUESDAY, OCTOBER 21.

ZOOLOGICAL SOCIETY, at 5.30.—E. G. Boulenger: Report on Research Experiments on Methods of Rat Destruction at the Zoological Society's Gardens.—Dr. A. Smith Woodward, Prof. F. Wood Jones, Prof. J. P. Hill, Prof. A. Keith, Mr. R. I. Pocock, Prof. G. Elliot Smith, and Others: Discussion on the Zoological Position and Affinities of Tarsius.

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