NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

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

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UNIVERSITY OF LONDON.

The following Public Lectures have been arranged :—

1. An Advanced Lecture on "THE 'RENAL PORTAL' SYSTEM AND ITS SIGNIFICANCE," by Prof. W. N. F. WOODLAND, D.Sc., F.Z.S., of Allahabad, at University College, Gower Street, W.C. 1, at 5 p.m., on Monday, May 31.

2. A Course of Two Advanced Lectures on "EVOLUTION IN OSTRICHES," by Dr. J. E. DUERDEN, of South Africa, at King's College, Strand, W.C. 2, at 5 p.m., on Thursdays, June 3 and 10.

3. A Course of Two Advanced Lectures on "THE EVOLUTION OF INSECTS, ESPECIALLY AS ILLUSTRATED BY AUSTRALIAN FOSSILS," by Dr. R. J. TILLYARD, M.A., F.L.S., Director of the Cawthorn Institute, New Zealand, at the Imperial College of Science and Technology, South Kensington, at 5 p.m., on June 14 and 17.

Admission is free to all the lectures, which are addressed to Advanced Students of the University and others interested in the various subjects.

P. J. HARTOG, Academic Registrar.

UNIVERSITY OF LONDON.

The Course of Four Advanced Lectures on "HIGH-FREQUENCY ALTERNATORS FOR RADIO-TELEGRAPHY," by Monsieur MARIUS LATOUR, of Paris, has now been arranged definitely to take place at the Institution of Civil Engineers, Great George Street, S.W. 1, at 5.30 p.m., on May 26, 27, 28, and 31.

Admission is free to the lectures, which are addressed to Advanced Students of the University and others interested in the subject. Syllabus obtainable on application.

P. J. HARTOG, Academic Registrar.

CHEMICAL SOCIETY RESEARCH FUND.

A Meeting of the Research Fund Committee will be held in June next. Applications for Grants, to be made on forms which can be obtained from the Assistant Secretary, Chemical Society, Burlington House, W. 1, must be received on or before Tuesday, June 1, 1920.

All persons who received grants in June, 1919, or in June of any previous year, whose accounts have not been declared closed by the Council, are reminded that reports must be returned by Tuesday, June 1, 1920.

LONDON COUNTY COUNCIL.

The Council offers a limited number of free places, tenable at the Imperial College of Science and Technology, South Kensington, S.W. 7. Candidates will be required to show that they are qualified to enter on the fourth, or post-graduate, year of the course of study selected.

Parents (or guardians) of candidates must be resident within the administrative County of London, except in the case of self-supporting candidates over 21 years of age on July 31, 1920, who must themselves be resident within the County.

Forms of application (T.2/255A) may be obtained from the EDUCATION OFFICER, London County Council Education Offices, Victoria Embankment, W.C.2, and must be returned not later than June 5, 1920.

JAMES BIRD,
Clerk of the London County Council.

SALTERS' INSTITUTE OF INDUSTRIAL CHEMISTRY.

Applications for Fellowships (£250 p.a.) of the above Institute are invited from those who in October next will have completed 3 years' training in chemistry and desire ultimately to enter upon an industrial career. Fellows will be required to pursue some branch of chemical investigation at an approved college or university. Full particulars of training and war service should be sent before July 1 to the DIRECTOR of the INSTITUTE, Salters' Hall, St. Swithin's Lane, E.C. 4.

THE ELLEN RICHARDS RESEARCH PRIZE

of $1000 is offered for award in the year 1921. Theses by women based on independent laboratory research are eligible for competition. For circulars of information and application blank, apply to Dr. FLORENCE R. SABIN, Johns Hopkins Medical School, Baltimore, Maryland.

NORTHAMPTON POLYTECHNIC INSTITUTE,

ST. JOHN STREET, LONDON, E.C.1.

TECHNICAL OPTICS DEPARTMENT.

The Governing Body invite applications for the appointment of HEAD of the TECHNICAL OPTICS DEPARTMENT, which was established in 1903 under the late Mr. S. D. Chalmers. The salary will be £640 per annum, rising to the maximum of £840 per annum by annual increments of £25.

Full particulars of the duties of the post and forms of application can be obtained by letter from :—

R. MULLINEUX WALMSLEY, D.Sc., Principal.

LONDON COUNTY COUNCIL.

COMPULSORY DAY CONTINUATION SCHOOLS.

APPOINTMENT OF PRINCIPALS.

The Council invites applications from men and women for appointment as PRINCIPALS of COMPULSORY DAY CONTINUATION SCHOOLS, to be established under the Education Act, 1918. Applicants will be required to produce evidence of good general education, recognised academical or technical qualifications, teaching or lecturing experience, and organising ability. Experience in social and welfare work is also desirable.

The inclusive scales of salary are as follows, according to size of school :—

Grade I. Men £500–£25–£600; women £400–£20–£475.
Grade II. Men £500–£25–£650; women £400–£20–£510.
Grade III. Men £500–£25–£700; women £400–£20–£550.

Applicants in the service of the Council who may be selected for these appointments and who are receiving salary within the limit of the above scales will be transferred at salaries not lower than their existing salaries.

Preference will be given, in the case of male candidates, to those who have served, or attempted to serve, with H.M. Forces.

Apply (enclosing stamped addressed foolscap envelope) to the EDUCATION OFFICER (T.3.). London County Council, Education Offices, Victoria Embankment, W.C.2. Form T.3/3 will then be sent and must be returned by 11 a.m. on May 26, 1920. Canvassing disqualifies.

JAMES BIRD,
Clerk of the London County Council.

SUNDERLAND EDUCATION COMMITTEE.

THE TECHNICAL COLLEGE.

SUPERINTENDENT OF TRAINING FOR CONTINUATION AND TECHNICAL SCHOOL TEACHERS.

Applications are invited for the above position, which is being established for the purpose of training intending teachers of Continuation and Technical Schools who have had some experience in engineering works and shipyards. The Technical College provides full-time day advanced courses in engineering and science of a university type, and part-time courses in naval architecture, engineering, building, etc.

The Superintendent of Training will be required to organise (i) courses of training for students who have completed both their full-time day advanced courses in engineering, etc., and their apprenticeship; (ii) short courses for part-time technical teachers engaged in engineering works and shipyards; (iii) short courses for technical teachers already in the employ of the Committee; and (iv) such other duties as may be detailed by the Committee.

Candidates must possess a University degree or its equivalent, and it is desirable that they should have some knowledge of Technical School work, and also some experience in welfare work for boys.

Salary according to scale, £450–£25–£550.

Applications, accompanied by three recent testimonials and references, must reach the undersigned by June 5, 1920.

HERBERT REED,
Chief Education Officer.

Education Department,
15 John Street,
Sunderland

SUNDERLAND EDUCATION COMMITTEE.

THE TECHNICAL COLLEGE.

DEPARTMENT OF MATHEMATICS AND MECHANICS.

The Committee invite applications for the position of LECTURER in the DEPARTMENT of MATHEMATICS and MECHANICS. Applicants must possess a University degree or its equivalent, training in Mathematics and Experimental Mechanics, and teaching experience in a Technical Institution.

Particulars of appointment, with scale of salaries and regulations governing appointments, may be obtained from the PRINCIPAL of the Technical College, Sunderland.

Applicants must apply by letter, with reference or copies of recent testimonials, to the undersigned on or before Monday, May 31, 1920.

HERBERT REED,
Chief Education Officer.

Education Department,
15 John Street,
Sunderland.

ASSISTANT CHEMISTS wanted at once

for the Admiralty Inspection Laboratories at Holton Heath. Candidates must have a qualification equivalent to that of the Associateship of the Institute of Chemistry, and must possess a sound knowledge of technical analysis, preferably of explosives.

Salary £270 per annum, rising by annual increments of £15 to £350 inclusive, and non-pensionable.

Applications, stating qualifications and experience, should be made by letter to the INSPECTOR OF NAVAL ORDNANCE, Holton Heath, near Wareham, Dorset.

THE UNIVERSITY OF LEEDS.

DEPARTMENT OF GEOGRAPHY.

Applications are invited for appointment to the ASSISTANT LECTURESHIP in GEOGRAPHY; salary £300. Particulars may be obtained from the SECRETARY, the University, Leeds.

ROBERT GORDON'S COLLEGE, ABERDEEN.

Applications are invited from persons desirous of being considered in connection with the Vacant HEADMASTERSHIP of this College—one of the largest Secondary Schools for Boys in Scotland. The enrolment for the current year is 917.

Hitherto the Headmastership has been held by the Principal of Robert Gordon's Technical College, but the Headmaster now to be appointed will hold office independently of the Principal of the Technical College and will be responsible directly to the Governors for the management of the School.

The salary offered is £800, rising on scale by annual increments of £25 to £1000, but the initial place on the scale will be determined by the qualifications and experience of the person appointed.

Thirty-six printed copies of a letter of application which should set out age, training, experience, and qualifications of the candidate, and be accompanied by thirty-six printed copies of testimonials, should be lodged with the subscriber on or before June 5, 1920.

The subscriber will send to any applicant desirous of seeing it a copy of the Prospectus of the School.

The person appointed will have to satisfy the Governors as to his health and will be expected to take office on September 1, 1920, or as soon as possible thereafter.

Canvassing, direct or indirect, is strictly forbidden, and will disqualify.

JAMES McKENZIE,
Secretary and Registrar,
Aberdeen, May 4, 1920. Robert Gordon's College.

BOROUGH POLYTECHNIC INSTITUTE,

LONDON, S.E. 1.

Applications are invited for the following appointments in the JUNIOR TECHNICAL SCHOOL and EVENING CLASSES:—

(a) SCIENCE MASTER for CHEMISTRY and PHYSICS.

(b) ASSISTANT MASTER for GEOGRAPHY and some other Form subject. Commencing salary, according to qualifications and experience, for (a) and (b) £240-315 by £10 to £440.

(c) ENGINEERING INSTRUCTOR for fitting and light forging, and Evening Classes in Pattern Making. Applicants must have been regularly trained and possess some teaching experience. Salary £275 by £10 to £350.

(d) An ASSISTANT PHYSICAL TRAINING and GYMNASTIC INSTRUCTOR, part time. Salary £225 at the rate of full time.

For form of application and particulars enclose stamped addressed foolscap envelope.

C. T. MILLIS, Principal.

BRIGHTON MUNICIPAL TECHNICAL COLLEGE.

Principal—W. MANSERGH VARLEY, M.A., D.Sc., Ph.D.

Applications are invited for the following positions:—

(1) LECTURER in the DEPARTMENT of MATHEMATICS, fully qualified to take charge of classes in Pure and Applied Mathematics up to the standard of the Final Arts and Science Degrees of London University.

(2) LECTURER in the DEPARTMENT of PHYSICS, fully qualified to take charge of classes in Physics up to the degree standard. Qualifications in Applied Electricity, though not essential, will be a recommendation.

Commencing salary in each case £300.

Forms of application may be obtained from the undersigned, and must be returned not later than June 11, 1920.

F. HERBERT TOYNE, Secretary.

54 Old Steine,
Brighton.

MANCHESTER MUNICIPAL
COLLEGE OF TECHNOLOGY

APPOINTMENT OF A DIRECTOR OF STUDIES

The Governing Body invites applications for appointment as Director of Studies in the College of Technology, at a salary of £600 a year.

The conditions of appointment and forms of application may be obtained from the Registrar, College of Technology, Manchester. The last day for the receipt of applications (which should be addressed to the Registrar) is Tuesday, 15th June.

Canvassing members of the Governing Body, either directly or indirectly, will disqualify a candidate.

UNIVERSITY OF THE PANJAB (LAHORE).

Applications are invited for the CHAIR of ZOOLOGY. Salary Rs. 15,000 a year (£1500 at the rate of 2s. a rupee). Applications (four copies) must be received not later than first post on June 14, 1920, by the undersigned, care of the University of London, South Kensington, S.W.7, from whom further particulars may be obtained.

A. C. WOOLNER, Registrar (on leave).

THE UNIVERSITY OF LIVERPOOL.

FACULTY OF ENGINEERING.

THE JOHN WILLIAM HUGHES CHAIR OF ENGINEERING: STRENGTH OF MATERIALS.

The Council invite applications for this chair. The duties of the Professor will begin and the appointment date from October 1, 1920. The appointment will be for life, subject to retirement at the age of sixty-five. Full particulars as to emoluments and duties can be obtained on application to the Registrar.

Applications, together with the names of at least three references, and (if the candidate so desires) twelve copies of testimonials, should be sent to the REGISTRAR not later than June 1, 1920.

EDWARD CAREY, Registrar.

THE UNIVERSITY OF LIVERPOOL.

FACULTY OF ENGINEERING.

THE HENRY BELL WORTLEY CHAIR OF METALLURGY.

The Council invite applications for this chair. The duties of the Professor will begin and the appointment date from October 1, 1920. The appointment will be for life, subject to retirement at the age of sixty-five. Full particulars as to emoluments and duties can be obtained on application to the Registrar.

Applications, together with the names of at least three references, and (if the candidate so desires) twelve copies of testimonials, should be sent to the REGISTRAR not later than June 7, 1920.

EDWARD CAREY, Registrar.

VICTORIA INSTITUTE.

SCIENCE AND TECHNICAL SCHOOL.

Headmaster: J. NEWTON FRIEND, D.Sc.

A GENERAL SCIENCE LECTURER required for Day and Evening Classes. Well qualified in Chemistry, Physics, and Mathematics. O.T.C. experience a recommendation. Preference given to Ex-Service Man. Salary £300-£25-£350. Duties commence September 1. Applications, with copies of testimonials, should be received by the undersigned not later than May 29.

THOS. DUCKWORTH,
Victoria Institute, Secretary for Higher Education.
Worcester.

THE ROYAL TECHNICAL COLLEGE, GLASGOW.

Applications are invited for the following posts in the SCHOOL OF CHEMISTRY:—

SENIOR LECTURER, with special qualifications in Organic Chemistry. Salary £400-£450 per annum, according to teaching experience.

JUNIOR ASSISTANTS. Salary £250-£300 per annum, according to qualifications.

Appointments to date as from September 1 next. Applications to be sent to the DIRECTOR, the Royal Technical College, Glasgow, not later than May 31.

CAMBRIDGESHIRE EDUCATION COMMITTEE.

CAMBRIDGE AND COUNTY SCHOOL FOR GIRLS, CAMBRIDGE.

WANTED, in September, a SCIENCE MISTRESS to teach Chemistry and Mathematics, and, if necessary, help with the Physics of the Middle School. Salary according to county scale, with allowance for previous experience. Forms of application, which should be returned immediately, may be obtained of the EDUCATION SECRETARY, County Hall, Cambridge.

May 8, 1920.

DEWSBURY TECHNICAL SCHOOL.

Headmaster: Mr. H. J. TAYLOR, F.C.S.

ASSISTANT LECTURER in CHEMISTRY wanted immediately. Part day and Evening work. Salary scale £250-£15-£360. Minimum will be increased according to experience.

Applications, stating age, qualifications, and full particulars of experience, to be sent to the undersigned.

GEORGE E. FEATHERSTON,
Secretary to the Governors.

Offices: Technical School, Dewsbury,
May 7, 1920.

UNIVERSITY COLLEGE, GALWAY.

THE PROFESSORSHIPS OF ANATOMY AND PHYSIOLOGY.

The Governing Body invites applications for these Professorships. Applications must reach me on or before May 31, 1920. Additional information in reference to these Professorships can be obtained from me.

J. HYNES, Secretary.

April 27, 1920.

For other Official Advertisements see page cxxx *and page* ii *of Supplement.*

THURSDAY, MAY 20, 1920.

Editorial and Publishing Offices:
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

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Telephone Number: GERRARD 8830.

The Officers Training Corps and the Universities.

IN a leading article on "The Universities and the Army," in NATURE for April 8, we referred to the Memorandum on the Army Estimates for 1920–21 published by the War Office, and quoted the words: "One of the important lessons of the war has been the extent to which the Army is dependent on the Universities." Of these lessons one especially was emphasised, viz. the necessity for the reorganisation of the Army on its educational side. We were told again and again, both during and after hostilities, that the war was primarily a scientific war—laboratory against laboratory, machine shop against machine shop, trained intelligence against trained intelligence—and it is gratifying to know that the War Office recognises that "the Universities responded to the call for help in a splendid manner." That they did so is an indisputable fact. Thousands of undergraduates and hundreds of their teachers, from junior assistant to full-fledged professor, switched off from classics, history, philosophy, natural science, and what not, to gunnery, engineering, motor transport, and so on. Chemical laboratories substituted investigations on explosives, anti-gas protectives, and smoke screens for routine qualitative and quantitative analysis; engineering laboratories concentrated their energies on the invention of depth charges, shell-gauges, and submarine engines; and the geologist relinquished the study of stratigraphy and palæontology to discover new sources of sand from which to manufacture glass. All this work was novel to the Universities, and, as many would add, foreign to their purpose and traditions; yet should another war of similar magnitude ever arise, can it be doubted that the Universities will again be called upon to play an even greater part in it than they did in the Great War of 1914–18?

If this be so, and if the Army be regarded as a profession, should its officers not receive a professional training, and where more appropriately and effectively than in the Universities? One of the most enlightened features of Army reorganisation introduced by Lord Haldane in 1907 was the institution of the Officers Training Corps in connection with the Universities. Had this tentative scheme of professional training for future Army officers received proper encouragement and been developed on suitable and elastic lines, the War Office might have had at its disposal in the autumn of 1914 a large reserve of trained officers who had passed through a properly devised University curriculum.

The military education committees of the various British universities and university colleges were recently sounded as to their views on the future of the Officers Training Corps, and from the replies received it would appear that most of them are unwilling to commit themselves to any plan of action until the attitude of the Army Council in reference to the Corps has been ascertained. What that attitude may be we have at present no means of finding out. We are informed that one of the largest Universities in the Kingdom answered the inquiry in the following terms: "The Military Education Committee are not of the opinion that it is desirable to take any further action at the present time until the Army Council have made a definite statement with regard to the future position of the Officers Training Corps, or to take any steps in regard to the creation of a Department of Military Studies until this official statement is issued." Several other Universities replied in similarly non-committal terms, and out of twelve, only one expressed any enthusiasm on the subject.

If the Army Council sincerely desires to make use of the Universities in the training of officers, let it say so in clear and unmistakable language, and indicate at the same time how and to what extent it is prepared to aid the Universities in carrying out its ideas. Some progress might be made, for example, if the Army Council would appoint a committee representing all departments concerned with Officers Training Corps, *with power to act and not merely to hear and report*, to meet and confer with representatives of the Universities, who on their side could submit the special needs of the Universities regarding Officers Training Corps. We cannot get rid of the suspicion that the War Office authorities are unaware of the work and organisation of the

newer Universities, and that they are still convinced that Great Britain has only two institutions worthy of the title. Have they any adequate conception, for example, of the extent and capacities for teaching and research of the faculties and departments of metallurgy, engineering, chemistry, and applied electricity at Sheffield, Leeds, Manchester, and Liverpool, to mention only one group of provincial Universities, and how it might be possible, in connection with a properly organised training corps, to provide instruction for cadets in those branches of specialised military work for which a particular University had special facilities and equipment, involving the application of science to war?

The Regulations governing the O.T.C. are dated 1912, but we have learnt much since then, and it is essential before these Regulations are revised and re-issued that the Army Council should take the Universities into its confidence, and, in consultation with their representatives, produce a scheme of training that shall conform to University practice and be within the range of University capacity, while at the same time meeting the requirements of the Army Council in its effort to obtain suitably trained men to command the various units of the Army of the future.

Relativity and Geometry.

The Foundations of Einstein's Theory of Gravitation. By Erwin Freundlich. Authorised English translation by Henry L. Brose. Preface by Albert Einstein. Introduction by Prof. H. H. Turner. Pp. xvi+61. (Cambridge: At the University Press, 1920.) Price 5*s.* net.

PURELY mathematical workers have often found occasion to remark on the prophetic vision of Riemann. He possessed that special genius which catches glimpses of truth, of no special significance to a contemporary, which one day are found to have an importance greater even than the seer himself had dreamed. Certainly this has proved so with much of Riemann's work. His famous *Habilitationsschrift,* "On the Hypotheses which lie at the Bases of Geometry," was presented to the faculty of philosophy at Göttingen in 1854, and, in an English translation by Clifford, was brought to the notice of the British public in the columns of NATURE (vol. viii., Nos. 183–84, pp. 14–17, 36, 37). It may be permissible to quote one or two prophetic phrases:

"It seems that the empirical notions on which the metrical determinations of space are founded, the notion of a solid body and of a ray of light, cease to be valid for the infinitely small. We are therefore quite at liberty to suppose that the metric relations of space in the infinitely small do not conform to the hypotheses of geometry; and we ought in fact to suppose it, if we can thereby obtain a simpler explanation of phenomena."

It is worthy of note that Riemann never speaks of space itself as being non-Euclidean. He carefully refers always to the metric or measured relations. The "ground" of these metric relations is to be sought in the nature of the reality underlying space. Is that reality a discrete manifoldness, or is it continuous? If the latter, then the "ground of the metric relations" must be sought in the properties of that reality, or, as he says, "in binding forces which act upon it." Could anything be more prophetic of Einstein's conception of gravitation? Then, as if to anticipate the conservative and the scoffer of to-day, he continues:

"The answer to these questions can only be got by starting from the conception of phenomena which has hitherto been justified by experience, and which Newton assumed as a foundation, and by making in this conception the successive changes required by facts which it cannot explain. Researches starting from general notions, like the investigation we have just made, can only be useful in preventing this work from being hampered by too narrow views, and progress in knowledge of the interdependence of things from being checked by traditional prejudices."

With this open mind, and the work of Gauss, Lobatchevsky, and Bolyai on the geometry of figures on curved surfaces to provoke thought, Riemann faces the possibility that the geometry of three dimensions of actual material bodies may not be so simple as Euclid's system suggests. Geometry in the ordinary sense is, in fact, eliminated; the metrical relations of bodies are "studied in abstract notions of quantity"; the results of calculation may afterwards be expressed in geometric form. Indeed, what is meant by the "length of a line," or a "line element," becomes far from clear from the geometrical point of view. It is merely some quantity which serves to distinguish one point from another. The question is asked: What type of magnitude may be constructed out of the quantities that serve to define two special points in a material body, which may conveniently be taken as a measure of their distinctness one from the other, first from a purely mathematical point of view, but afterwards by an empirical test of its abiding value. Riemann is led to use the general quadratic differential form as the simplest possible expression.

It is easy for one writing now to see the organic connection between Riemann's thought and the step made by Einstein in passing from the special principle of relativity propounded in 1905 to the general theory now established. The recognition of the relative nature of time measurement had already been made in the special principle, and Minkowski quickly perceived that our separate concepts of space and time were thereby brought into a unity. It seems now but a short step to apply Riemann's analysis to this four-dimensional view of the universe.

But questions still linger; the romance of relativity, its sweeping comprehensiveness, leave us breathless. When Dr. Freundlich tells us that "space is banished out of physical laws altogether: just as æther was eliminated out of the laws of electrodynamics by the special theory of relativity," we must pause and ask ourselves if enthusiasm is not going too far. Dr. Freundlich himself finds the mainspring of Einstein's method in two fundamental postulates: (i) that of continuity; (ii) that of causal relationship between only such things as lie within the realm of observation. It was the craving for *continuity* that gave rise to Faraday's conception of tubes of force, developing gradually into the electromagnetic æther. It is the instinctive faith in the second postulate that leads the timid to distrust the formidable array of differential equations between an army of variables that represent the gravitational field in Einstein's theory.

No physical theory has the power to forbid the mind to use the firm scaffolding of Euclidean truth on which to build its own representation of the universe. True, it may be that the representation is not so simple as we had thought; that the Euclidean element of length does not correspond exactly to a measured interval in a rigid body. But the work of the exponents of relativity is not finished until an added clearness is given by them to the picture of how natural phenomena are related. The æther must not be put on the scrap-heap, but must be rehabilitated. Space must not be spoken of as warped, for that is to leave far behind the essential nature of space as a mode of apprehension. The only true continuum is that which the mind conceives. Matter cannot be a singularity in mental space; it can only be a singularity in the picture drawn upon that background. Matter is one and minds are many. So many minds, so many pictures of matter. The correspondences between the pictures are the grounds of our intellectual intercourse, the only evidence of the external world which we possess.

To turn over the pages of this pamphlet is to encounter many questions; nevertheless the reader will have nothing but thanks to offer to the author, and especially to Mr. Brose, who, while yet a prisoner in an enemy country, found solace in truth that transcends racial strife, and translated it for our enjoyment. E. CUNNINGHAM.

Colloidal Therapy.

The Use of Colloids in Health and Disease. By Alfred B. Searle. With foreword by Sir Malcolm Morris. (The Chadwick Library.) Pp. vii+120. (London: Constable and Co., Ltd., 1920.) Price 8*s*. net.

BASED on a lecture delivered at the request of the Chadwick Trustees, this volume provides in compact form an account of the principal facts which are known at the present time regarding matter in its colloidal form, with special reference to the utilisation of colloids in the normal animal organism and in the treatment of disease.

We find a lucid account of the physical properties of colloidal matter and of its reactions in the presence of ionising currents, of electrolytes, of radiations, etc. There is explained in simple scientific language the colloidal nature of cellular protoplasm and the selective permeability of cell membranes for salts and colloids.

The importance of the relatively high content of the protective colloid, lactalbumin, in human milk in relation to its digestibility is emphasised, and the means are stated by which cow's milk may be rendered more suitable for human consumption. In discussing the colloidal nature of the blood, reference is made to the adsorption theory of the conveyance of blood gases and to the phenomena of hæmolysis; an isotonic saline solution is, however, 0·9 per cent. sodium chloride.

The modern processes for precipitating colloidal matter in sewage and drinking water, and the use of soap as a detergent, are also briefly reviewed. The author suggests that the hygienic effect of sea-air is due to the presence in it of particles positively charged by the beating of the waves on the shore, which particles precipitate negatively charged bacterial and other colloids; and in regard to the invasion of the body by micro-organisms, he considers that disturbance of the normal colloidal condition of the body-cells or fluids by undesirable electrolytes, salts, or colloids of the "opposite" sign is an ætiological factor.

The author has devoted considerable space to accounts of the preparation of colloidal sols and of their use in therapeutics. In the latter respect he has digested the bulk of the recent and rele-

vant medical literature on the colloidal remedies now in the market. The relative value of colloidal drugs in treatment is still *sub judice,* and we can only hope that the author's optimism regarding their effects as therapeutic agents may be justified in the future. In this section we note several misprints, such as "epiditymitis," "granulama pupendi," and "leishmonnoris," to mention only a few, and the assertion that the colloidal state is the ideal one for the administration of alkaloids is contrary to the evidence afforded of the inefficacy of colloidal quinine and cocaine. In the course of the work the author makes many speculations on the *rôle* of colloids in physiology and on their possibilities in treatment, speculations which form food for reflection if one is unable to assimilate them all as truths.

The volume, to which Sir Malcolm Morris, whose pioneer work with colloids in skin diseases is well known, contributes an interesting and hopeful foreword, forms a helpful introduction to the subject of colloids in their relation to physiology, pharmacology, and therapeutics, and may be found useful by medical practitioners and others who desire to have a general and not too scientific account of the subject.

Nature Pictures.

Twenty-four Nature Pictures. By E. J. Detmold. (London: J. M. Dent and Sons, Ltd., n.d.) Price 5 guineas net.

SEVERAL important works have recently been published portraying and describing the birds and mammals of the British Islands. Some of these publications are expensive, others appeal to a slender purse; but, whether the lover of such books is able or willing to spend much or only a little on animal pictures, he is fortunate in having a good deal of scope for choice, many of the works that we have seen of late being excellent in every way, combining artistic merit with scientific accuracy.

In introducing a new work on the higher animals to the British public, therefore, it behoves its author to show that it possesses some outstanding feature of merit which may serve as its *raison d'être.* The work under consideration cannot be regarded as serving any zoological purpose, since the subjects are so few in number. Hence any merit it may lay claim to must be sought from its purely artistic side. But such pictures, to be satisfactory, should be accurate in form and colour, so that, while appealing to the artistic sense, they do not at the same time offend the scientific eye; and herein the nature-studies of Mr. Detmold are decidedly faulty.

In a series of twenty-four plates the artist portrays altogether five species of mammals, twenty birds, a fish, a crab, and a lobster. Zoologically speaking, the two crustaceans are, in our opinion, the most successful portraits in the series. The majority of mammal and bird studies are distinctly disappointing, and lead one to fear that they have been drawn from specimens supplied by some unskilful taxidermist. They seem to lack the subtle and delicate curves of beauty we are accustomed to associate with the living and healthy animal, while in some cases the colouring is faulty. The proportions, too, between the parts of the body are sometimes incorrect, even allowing for the effects of foreshortening. In the painting of plumage and pelage there are a peculiar "lumpiness" of surface and angularity of outline which are foreign to our ideas of animal form and beauty. Whether the artist has allowed himself to be carried away by the licence proverbial to his profession, or is endeavouring to formulate a new style of composition and portraiture, we cannot say, but the effect, at least from a zoological point of view, is disappointing and at times irritating.

The surroundings of the various subjects are certainly artistic and original, but in some plates the environment is overloaded with detail, while in others its artificiality is oppressive, and suggests tapestry or wall-paper rather than a background for a "nature-picture." W. E. C.

Our Bookshelf.

General Science: First Course. By L. Elhuff. Pp. vii+435. (London: G. G. Harrap and Co., Ltd.) Price 5*s.* net.

THAT a pupil's first view of science should be a broad one has been more generally recognised in the United States than in this country. The routine of measurements and weighings, which is all that so many of our children know as science, fails to arouse enthusiasm except as a relief from work which is still more dull. Teachers who are breaking away from this system have been helped by more than one recent American publication. Their attention is confidently directed to the volume now under review.

In its general outlines the book does not differ widely from some of the best of its kind, but it is exceptional in that stress is laid in the earliest chapters on the value and the means of maintaining health. To the question "Why study science?" the answer is given: "To learn how to live." That is kept constantly in view throughout the book. In his preface the author puts the following first among the results which he hopes may be achieved: "A desire to grow strong

in body and mind and to remain free from disease. . . . Successful work on the part of many boys and girls is dependent upon this desire becoming strong enough to rule the body." So it is not surprising to read as an exercise to be set to pupils: "Notice what effects tobacco, alcohol, opium, etc., have upon those who use them." But another, "Observe whether tea and coffee affect the health and 'temper' of parents," makes one wonder whether tactless observation might not have even more effect than the stimulants!

Where it follows lines which are already becoming conventional in America the book is good; in the more novel parts it is even better.

A Geographical Bibliography of British Ornithology from the Earliest Times to the End of 1918. By W. H. Mullens, H. Kirke Swann, and Rev. F. C. R. Jourdain. Part 1. Pp. 96. (London: Witherby and Co., 1919.) Price 6*s.* net.

MESSRS. MULLENS AND SWANN have already made ornithologists their debtors by compiling a "Biographical Bibliography of British Ornithology" (completed in 1917). Of this the present work is a supplement or continuation, the books and articles being now arranged under counties. The Rev. F. C. R. Jourdain has shared the labour. The aim of the authors has been to give an account, as complete as possible, of the literature and records relating to the avifauna of each county. This will be of great value to local workers, and there is good sense in Gilbert White's remark, quoted on the title-page: "Men that undertake only one district are much more likely to advance natural knowledge than those that grasp at more than they can possibly be acquainted with; every kingdom, every province, should have its own *monographer*." The labour of making this bibliography must have been very great; it has extended over six years, and has meant the consultation and analysis of a huge mass of literature. There are to be six parts, and those which have appeared represent arduous and useful work well executed.

The Philosophy of Conflict: and Other Essays in War-Time. By Havelock Ellis. Second series. Pp. 299. (London: Constable and Co., Ltd., 1919.) Price 6*s.* 6*d.* net.

MR. ELLIS is likely to find readers for this collection of essays. His social studies turn on sex-problems, often shrewdly handled. His literary and anthropological studies are dominated by his sense of the picturesque. He is arrested by the picture-making metaphors of Conrad, and by the picturesque theories of Sollas in prehistoric anthropology. In his essays in this last group he reminds us of his own portrait of Jung, wandering "with random, untrained steps, throwing out brilliant suggestions here and there." But in the essay in which this portrait occurs he is on his own ground, and justifiably dwells on his part in introducing to English readers the picturesque psychology of Freud.

Letters to the Editor.

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

The Cost of Scientific Publications.

MAY I add a word to this most interesting discussion from the point of view of the society with which I am most concerned?

The London Mathematical Society was founded by De Morgan and others in 1865, and has steadily improved its position until it is admittedly the leading mathematical society in the country. It is a comparatively small society, and its activities are almost entirely concentrated on the publication of its Proceedings, to which purpose practically its whole income is devoted. It has no paid staff of any kind.

Before the war the society was able to publish annually about 500 pages of original research, at a cost of some 300*l.* to 350*l.* Now a volume of 400 pages only, costs some 600*l.*, and such slight increase of income as there has been is entirely insufficient to meet the new situation. Most of the members are life-compounders, and it is exceedingly difficult to raise the membership beyond a certain point; it was 290 in 1918, and is now about 340. A committee is considering what is possible in the way of economy or increase of charges, but every increase of charges makes it harder to secure new members, and the only substantial economy possible lies in a further limitation of output.

If the society is to maintain the position won by years of effort before the war, it must at all costs keep up both the quality and the size of its Proceedings. In particular it must continue to attract the best work of young mathematicians; and it cannot do this if it has to hamper them at every turn by incessant demands for condensation. A considerable part of the volumes must always be occupied by the work of men of established reputation, and if they are to be further curtailed it is the younger men who will in the first instance be likely to suffer.

The society has during the last year been able to obtain some aid from the fund under the control of the Royal Society, but it is plain that the demands on the fund are likely to multiply, and all possible pressure should be brought to bear on the proper authorities to augment it.

G. H. HARDY,
Hon. Sec. London Math. Soc.
New College, Oxford, May 15.

IN the leading article in NATURE of May 6 on the cost of scientific publications, reference is made to the critical financial position of those of our scientific societies which have no popular means of adding to their income. The position is serious. The scientific worker, upon whom, to a great extent, a scientific society depends for maintenance, is rarely in a position to add to his financial obligations, and the interested person from whom the society also receives considerable support is often in a similar position. If a society is to be efficient, the library must be kept up, the standard of publications be maintained, and its salaried staff receive at least a living wage. How is this to be done? Apart from external aid, there are only two ways—by exercise of rigid economy, and by increased contributions from the members. It is not economy to starve the library, and economy in publication must be employed with

great discretion. The dignified quarto which supplies a link with the early days of the society may be suspended, illustrations reduced to the absolute minimum, communications condensed or reduced, and every conceivable means adopted to avoid expense; but with a diminished sum available for printing, and printing costs trebled, it is obvious that the efficiency of the society as a means of publication must be seriously reduced.

This result bears heavily on oversea members The member within reach of town has all the advantages of the society; he can attend the meetings, consult the library, and meet his colleagues at the society's rooms; the country member is less favourably situated, but he has at least the privilege of borrowing from the library. The only material advantage received by the oversea member is the scientific publications of the society. The oversea members are an important part of the society, which, though "of London" in style, is world-wide in interest and membership. Our colleagues oversea, though in many cases supporting their own local society, consider it an honour to belong to the mother society at home, and the aim of the mother society is to strengthen the bond and to show the worker oversea that he is both welcome and necessary. Any step, therefore, which tends to lessen the advantages reaped by the oversea member must be avoided.

Apart from external aid there remains only the increased contribution from the individual member. An increase in the subscription will fall hard on many members; but the claims of a society which represents one's work or the scientific interest of one's leisure will not easily be set aside. A man or woman does not join a scientific society in a commercial spirit, but because a congenial atmosphere is there found, or, in the highest motive, because it is an obligation and an honour to help forward the society which represents one's own branch of science. If each member will consider seriously the position of his society, the claim for external aid, amply justified by the value to the community of the scientific work of the society, will come with increased power.

A. B. RENDLE.

THE leading article in NATURE of May 6 has so admirably stated the case for assistance towards the publications of scientific societies that it is almost needless to add further arguments. Nevertheless, there is one point which seems to require attention, namely, that during the last two years, when the pressure of enhanced prices in the printing trade has made itself felt, there has been an attempt on the part of societies subject to this burden to palliate it by means which threaten to change the character of the meetings. To avoid the heavy cost of papers embodying recent research, there has developed a marked tendency to arrange for lectures and demonstrations of a kind which do not require publication in detail, to the disadvantage of original memoirs which demand illustration and extensive text. Should this procedure continue, it is plain that research will suffer, investigators will not be ready to produce the results of their work in the meetings, and the value of the societies' issues will be diminished.

If assistance of the kind advocated can be secured, former methods can be resumed; if that assistance is denied, it is to be feared that, in spite of stringent economy or increased subscriptions on the part of the societies, the publications will suffer; for the maintenance charges must first be met before the balance of income is available for printing memoirs.

B. DAYDON JACKSON.

I DO not suppose that there is a single editor of a scientific journal who will not read with sympathy and gratitude of your effort to obtain financial support for such publications in view of the enormously increased cost of paper and printing. In the case of the *British Journal of Psychology*, with which I am specially connected, the subscription is being raised for the second time since the war, whilst no class has suffered more as regards income than that from which the subscribers to scientific journals are drawn.

CHARLES S. MYERS.

30 Montagu Square, W.1, May 10.

The Indian Chemical Service.

SIR P. C. RÂY's objections to the proposal to form an Indian Chemical Service are based upon the fact that the Education Department of India has failed to realise the importance of research in connection with university teaching. However, I feel sure that he would not advocate the abolition of that Department, much less would he wish to see the Indian Education Service a mere adjunct to some other branch of the public services, without even provincial directors to look after the interests of himself and his colleagues. Every member of a Service knows that, in the event of a difference arising between himself and a member of another Service, he will have the support of a senior member of his own Service at each stage until the matter is perhaps settled by the Viceroy himself. Even directors-general and members of council are human, and inclined to support members of their own Department against the world.

Prof. Thorpe does not dwell at any length on the personal aspect of the problem, but I gather from his letter that he appreciates the importance of it. I do not doubt that he has grasped the fact that, while the members of such units as the Geological Survey of India or the Indian Medical Service are contented with the conditions of their service, grave discontent prevails amongst the numerous scientific men attached to, but not members of, organised Services. The fact that many men holding such positions have thrown up their appointments and come home disgusted has added considerably to the difficulty in recruiting scientific men, and particularly chemists, for service in India. There is no alternative to the bureaucratic system of government for India, and the proposed scheme provides for its inherent defects.

It is, of course, essential that the director-general and the directors of provincial institutes should be chemists who have proved their capacity for research. The Geological, Botanical, and Zoological Surveys of India seem to get on fairly well under directors-general who are scientific experts, and I do not see the necessity for assuming that the head and subheads of the Chemical Service will be any less competent than those who have done distinguished service for India in other branches of science.

Knowing something of India, I believe that the proposed scheme is sound, and I wish it every success.

M. W. TRAVERS.

Beacon Hall, Priory Gardens, Highgate,
May 15.

A New Method for Approximate Evaluation of Definite Integrals between Finite Limits.

1. If $f(x)=a+bx+cx^2+dx^3+gx^4+hx^5+jx^6+kx^7+lx^8+mx^9$, the value of $\frac{1}{4}[f(\frac{1}{10})+f(\frac{4}{10})+f(\frac{6}{10})+f(\frac{9}{10})]$ is

$$a+0{\cdot}5000b+0{\cdot}3350c+0{\cdot}2525d+0{\cdot}2028g+0{\cdot}1696h+0{\cdot}1455j+0{\cdot}1270k+0{\cdot}1120l+0{\cdot}0994m$$

which is approximately identical with

$a+0\cdot5000b+0\cdot3333c+0\cdot2500d+0\cdot2000g+0\cdot1667h+0\cdot1429j+0\cdot1250k+0\cdot1111l+0\cdot1000m$,

that is, with

$$a+\tfrac{1}{2}b+\tfrac{1}{3}c+\tfrac{1}{4}d+\tfrac{1}{5}g+\tfrac{1}{6}h+\tfrac{1}{7}j+\tfrac{1}{8}k+\tfrac{1}{9}l+\tfrac{1}{10}m,$$

which is $\int_0^1 f(x)dx$.

An approximate evaluation of $\int_0^1 F(x)dx$ is therefore given by

$$\tfrac{1}{4}[F(\tfrac{1}{10})+F(\tfrac{4}{10})+F(\tfrac{6}{10})+F(\tfrac{9}{10})].$$

2. The following table shows for several functions the value of the integral and the approximate evaluation by this four-ordinate rule and by two *seven*-ordinate rules in common use, viz. :—

Simpson's rule :—

$$\int_0^1 F(x)dx=\tfrac{1}{18}[F(\tfrac{0}{6})+F(\tfrac{6}{6})+2\{F(\tfrac{2}{6})+F(\tfrac{4}{6})\}+4\{F(\tfrac{1}{6})+F(\tfrac{3}{6})+F(\tfrac{5}{6})\}],\ \text{approx.}$$

Weddle's rule :—

$$\int_0^1 F(x)dx=\tfrac{1}{20}[F(\tfrac{0}{6})+5F(\tfrac{1}{6})+F(\tfrac{2}{6})+6F(\tfrac{3}{6})+F(\tfrac{4}{6})+5F(\tfrac{5}{6})+F(\tfrac{6}{6})],\ \text{approx.}$$

$F(x)$	$\int_0^1 F(x)dx$	New rule	Simpson	Weddle
Semicircle $(x-x^2)^{\frac{1}{2}}$	$\frac{\pi}{8}=0\cdot3927$	0·3949	0·3815	0·3835
Quadrant $(1-x^2)^{\frac{1}{2}}$	$\frac{\pi}{4}=0\ 7854$	0·7868	0·7775	0·7789
$(4x-x^2)^{\frac{1}{2}}$	$\frac{2}{3}\pi-\frac{\sqrt{3}}{2}=1\cdot228$	1·231	1·217	1·219
$\log(1+x)$	$2\log 2-1=0\cdot3863$	0·3859	0·3863	0·3863
e^x	$e-1=1\cdot718$	1·720	1·718	1·718
$\frac{1}{1+x}$	$\log 2=0\cdot6931$	0·6937	0·6932	0·6931
$\frac{1}{2+x}$	$\log\frac{3}{2}=0\cdot4055$	0·4056	0·4055	0·4055
$\sin x$	$1-\cos\frac{180^\circ}{\pi}=0\cdot4597$	0·4593	0·4597	0·4597

3. The approximation is convenient for the practical determination of the area of a closed curve, such as an indicator diagram. The arithmetical mean of the ordinates at one-tenth, four-tenths, six-tenths, and nine-tenths of the range is the mean ordinate for the range.

The decimal division of the range, the use of only four ordinates, the extremely simple arithmetic involved, and the degree of accuracy attained should make the rule of practical value.

A. F. DUFTON.

Trinity College, Cambridge,
April 30.

British and Metric Systems of Weights and Measures.

ARE not those who discuss the relative claims of 4 mils and 5 mils as the substitute for the penny in a decimal division of the pound merely trying to minimise the disadvantages of what must in any case be a change for the worse? It seems that the advantage of any given system of weights or measures lies largely in the facilities that it offers for the division of a sum or quantity into equal parts. In this respect any decimal system is deficient by the absence of the factor 3, and by the frequency of the factor 5, which is of much less use than 4 for practical purposes. The *reductio ad absurdum* of the metric system seemed to be reached in the issue in Portugal some years ago of a 2½ reis postage stamp (they now call it ¼-cent). A rei is one-thousandth part of a milrei or dollar, about equal to one-twentieth of a penny—surely a small enough unit for any purpose, and yet it is found necessary to halve it!

The following comparison seems instructive :—

No. of farthings in one pound $=960=2^6\times3\times5$.
This has 11 factors between 1 and 20,
20 factors between 1 and 100.
No. of inches in one mile $=63{,}360=2^7\times3^2\times5\times11$.
This has 14 factors between 1 and 20,
34 factors between 1 and 100.
No. of ounces in one ton $=35{,}840=2^{10}\times5\times7$.
This has 9 factors between 1 and 20,
17 factors between 1 and 100.
No. of grains in one lb. troy $=5760=2^7\times3^2\times5$.
This has 13 factors between 1 and 20,
26 factors between 1 and 100.
No. of seconds in one day $=86{,}400=2^7\times3^3\times5^2$.
This has 13 factors between 1 and 20,
32 factors between 1 and 100.

Contrast with these :—

No. of millimetres in one kilometre, or of grammes in one metric tonne $=1{,}000{,}000=2^6\times5^6$,
which has only 7 factors between 1 and 20,
14 factors between 1 and 100.

If all the above five English systems be taken together, it will be found that :—

The factor 2	occurs 37 times
„ „ 4	„ 17 „
„ „ 8	„ 11 „
The factors 3, 6, and 12	occur 8 „
„ „ 5, 10, 16, and 20	„ 6 „
The factor 15	occurs 5 „
The factors 9 and 18	occur 3 „
And the factors 7, 11, and 14	„ once each.

Now, though it cannot be contended that the man who wants to divide 100*l.* into seven parts is helped by the fact that there are 28 lb. in a quarter, or he who would divide a ton into eleven parts by the number of yards in a furlong, yet it seems worthy of note that in our admittedly heterogeneous system all the numbers below 20, except 13, 17, and 19, should be represented as factors, and that to an extent so nearly proportional to their probable utility.

M. E. YEATMAN.

Parliament Mansions, May 7.

Scientific Apparatus and Laboratory Fittings.

I AM surprised to see that Prof. W. M. Bayliss, who writes in NATURE of May 6 on the proposed Anti-Dumping Bill, has misunderstood the Bill so far as it relates to scientific instruments. This Bill does not propose a tariff, but prohibition, except under licence.

The British Optical Instrument Manufacturers' Association has urged the Government to act by prohibition except under licence rather than by tariff, and this is what the Bill proposes. It has always considered that the effect of a tariff might, as Prof. Bayliss suggests, give "no inducement to the makers to improve the quality"; and it has urged that licences should always be freely granted where articles were not being made in the required quantity or up to the standard of quality of goods that could be imported from abroad.

Prof. Bayliss's desire for "free import of such apparatus *until* equally good material is to be had cheaply at home" is provided for by the Bill with the exception of the one word "cheaply," and I suggest that he has, perhaps unintentionally, given the impression that a tariff on goods which either are not or cannot be made in this country has been proposed.

The whole question appears to be: Are scientific men prepared to pay more for British-made scientific instruments of approved quality to meet higher wages or the depreciation of foreign currency rather than have the whole industry extinguished in this country?

With the mark at something like one-tenth its pre-war value, it is obvious that no instrument can be produced in this country to compete as regards price with those made in Germany. The Government, through the British Scientific Instrument Research Association, is giving State aid as regards perfecting processes. Sir Herbert Jackson (who is director of the association) is already producing most valuable results; but if financial considerations make it impossible to sell the articles so produced, it does not meet the case.

Quite apart from the danger to the State which will ensue in case of another war if the scientific industry does not exist, surely it must be evident that science cannot develop properly in any country that cannot produce at least the majority of its own scientific instruments.

A much closer combination between scientific and practical men than existed before the war is required. It has already commenced, and I desire to take this opportunity of explaining that the association of which I am president has a technical committee the members of which place their services at the disposal of the scientific world to discuss all questions the solution of which depends on the production or development of scientific instruments.

CONRAD BECK,
President of the British Optical Instrument Manufacturers' Association.
2–3 Duke Street, St. James's, Westminster, S.W.1, May 10.

PROF. BAYLISS'S letter in NATURE of May 6 raises a subject which is of the greatest interest to manufacturers, as well as to users of all classes of scientific apparatus. We do not think that anyone will dispute the contention that scientific workers should have the very best apparatus which is available, and wherever British apparatus is not up to the standard of foreign competitors there is no doubt that the importation of the foreign articles should be allowed. It is, however, quite a different matter when orders are placed by scientific workers, hospitals, etc., with foreign firms on account of the latter being able to quote lower prices than the English manufacturers can do at the present time.

It has recently come to our knowledge that an important hospital supported chiefly by voluntary contributions has placed a large order for X-ray equipment abroad on account of the lower price quoted, not because the staff was of the opinion that better apparatus could be obtained from this source, as, in fact, we were definitely assured that, except for price, our models were preferred. We would ask the committee which was responsible for placing that order whether it had carefully considered the effect of its act, especially should it be repeated to any considerable extent. It is generally acknowledged that, prior to the war, the British manufacturers were not giving to the medical world the very best service, and both medical men and manufacturers have often asked the reason why. It is too large a question to go into the fundamental reasons, and opinion would no doubt differ as to these; but there is no doubt that in the year 1914 there did not exist a sufficient demand for British X-ray apparatus to allow manufacturers to work on a large enough scale to ensure satisfactory service and economical production. During the war the cutting off of foreign supplies and the increased demand for apparatus enabled the firms concerned to venture on a bolder policy, until by the end of the war there were established in the country adequate manufacturing facilities. After the armistice the Government orders dropped to zero, but the demands for up-to-date equipment from private hospitals, and from foreign quarters which had been starved during the war, were sufficient to fill the gap and to enable various firms to carry on their manufacturing programme without undue alarm for the immediate future.

The past year has been one of great difficulty in the manufacturing world, and, with the publication and issuing of catalogues and price lists scarcely yet complete, a great deal of the heart will be taken out of British manufacturers if they find that, owing to a circumstance over which they have no control, they are going to lose a large part of their home trade. The circumstance to which we refer is that of the rate of foreign exchange, against which tariffs, unless extremely heavy, are of no value whatsoever. It is very difficult to obtain trustworthy information as to the prices at which German and Austrian goods can really be delivered in this country, but in one specific instance we ourselves are being offered one of our staple articles of manufacture at a price which is very considerably below the actual cost of the raw material which we use in the manufacture. Prior to the war the articles were not made in this country at all, and it was only by the employment of considerable research and a heavy initial expenditure that their production was assured and perfected. We do not think that some scientific workers, medical men, and others quite realise that under present conditions high prices are essential in connection with scientific apparatus as with all other commodities, and that if they wish to obtain really good service from British manufacturing firms it is necessary that the amount of apparatus purchased from them should be considerable. Then when our Colonial and foreign friends come to this country for instruction and advice, and find that instruments of British manufacture are employed by the doyens of the scientific world, our foreign trade will develop, and increased production will then lead to lower prices with better quality.

B. H. MORPHY, Man. Director,
The Cox-Cavendish Electrical Co., Ltd.
Twyford Abbey Works,
Acton Lane, Harlesden, N.W.10.
May 12.

REFERRING to Prof. Bayliss's letter on scientific apparatus from abroad, we cannot quite agree with his view that the instruments made in this country are more costly than those purchased from the Continent. We think that when conditions in this country are more settled Prof. Bayliss will find that foreign prices are equal to, if not in excess of, those ruling on this side, owing to the considerable increase in wages and raw materials. At the moment the rate of exchange makes the prices seem low as compared with those in this country, but can Prof. Bayliss obtain delivery at the low prices?

If manufacturers in this country do not receive the

support of the public, they cannot be expected to produce scientific instruments to compete with the standard of excellence obtained on the Continent—for several reasons, amongst which the following are the most important where microscopes are concerned.

The number of skilled lens-workers capable of making high-power objectives is very small, and to train suitable labour for, say, making 1/12-in. oil immersion objectives of the ordinary achromatic series could not be accomplished in less than three or four years. A dozen or so of these skilled workers could be given employment immediately.

The profit on microscopes is not very remunerative, and unless some protection such as importation under licence is established, no fresh capital is likely to be forthcoming; and even if it is, some years will elapse before those investing their money will see any return, on account of the time required to train labour for this highly skilled occupation.

If some protection is granted to the trade, the manufacturers must set a higher standard of excellence on their goods than they did before the war, otherwise they cannot expect support from the public; but if support is forthcoming we feel sure manufacturers will reciprocate by turning out goods not only at a lower price, but also of a better quality.

It was chiefly on account of the excellent standard attained that Continental manufacturers obtained the lead before the war. Individual pieces of apparatus have been made in England equal to any produced on the Continent, but, unfortunately, only a very small percentage of the supplies ever reached the standard. If English manufacturers will only pay more attention to inspection, and set a much higher standard of quality than they did before the war, there is no reason why the purchasing public should buy foreign-made instruments. There is also no reason why any instrument previously manufactured on the Continent should not be produced here.

C. BAKER.

244 High Holborn, London, W.C.1.
May 14.

WE do not think Prof. Bayliss and Mr. Munby will find that the prices of British-made laboratory apparatus have increased to the same extent as have those of some other manufactured articles—for example, leather or metal goods, soap, stationery, etc.

Last week a catalogue reached us from a well-known German firm specialising in certain optical goods. The pre-war prices are subject to an advance of 200 per cent., the basis of payment being 20 marks = 1*l*., and cash to the value of 50 per cent. of the order is required at the time of placing it. Thus such imported goods are three times as costly as before the war.

At present the prices of our instruments are from 75 to 120 per cent. above pre-war German prices for instruments which are now admittedly more convenient and efficient. This is particularly the case in regard to one instrument, which for forty years prior to the war had been built by a German firm practically upside down.

Again, we supply certain optical testing instruments which are set at the National Physical Laboratory to an accuracy six times greater than was found in the standard instrument of German origin.

It would seem essential that the manufacture of scientific apparatus in this country should be encouraged to the fullest possible extent in order that trained workers may be available in emergency; for even supposing war to be impossible in the future, if such manufactures become the monopoly of another country we shall, sooner or later, be paying still higher prices by reason of that monopoly.

As no specific kind of apparatus is mentioned by Prof. Bayliss or Mr. Munby, we have replied as makers of two particular classes of optical testing instruments. These instruments are entirely British as regards optical and mechanical design, as no progress is to be made by adopting and copying designs which have easily demonstrable shortcomings.

BELLINGHAM AND STANLEY, LTD.

71 Hornsey Rise, London, N.19, May 10.

WITH regard to the letters by Prof. Bayliss and Mr. Munby in NATURE of May 6, we would say that, generally, we are in agreement with the report of the Branch Committee on Scientific Apparatus, of which I was chairman, an abstract of which is published in the report of the Engineering Trades (New Industries) Committee of the Ministry of Reconstruction.

We have very little sympathy with those who would bolster up our industry by levying heavy duties on imports, and, generally, we think that the result of such a policy would be to increase the cost of home-made goods without improving their quality; but there is a good deal to be said for preventing goods made abroad being dumped in this country at prices lower than those prevailing in the country of their origin. The inevitable result of permitting this is to discourage or kill our own industry, and this is well exemplified in the case of our watch industry.

Scientific men cannot, however, have dumped and, consequently, cheap scientific apparatus from abroad and at the same time a flourishing apparatus industry at home producing goods of the highest quality at the lowest prices.

WM. TAYLOR.
(Taylor, Taylor, and Hobson, Ltd.)

Leicester, May 11.

WITH reference to Prof. Bayliss's letter in NATURE of May 6, members of this association are in complete agreement that scientific workers should be able to obtain the very best quality apparatus.

I quote the wording of our communication to the Board of Trade (Scientific Instrument Branch) in connection with the proposal to form a special Licensing Committee on which scientific authorities would be represented: "They would have power to allow the imports of all apparatus which cannot be produced of efficient quality or in sufficient quantities in this country to meet the demands."

But the menace to British manufacturers is the abnormal rate of exchange with Germany, which enables apparatus to be brought in at anything from one-fifth to one-tenth of the normal value.

No workshop organisation or economy can possibly compete with such values, and it is during this unprecedented and abnormal state of international finance that British manufacturers are asking for temporary prohibition of imported apparatus at purely artificial prices.

H. W. ASHFIELD,
Secretary, British Lampblown Scientific Glassware Manufacturers' Association, Ltd.

2–3 Duke Street, St. James's, London, S.W.1,
May 11.

Naturally Fractured Eocene Flints.

AT a meeting of the Geological Society of London, held on May 5, Mr. S. Hazzledine Warren read a paper entitled "A Natural 'Eolith' Factory beneath the Thanet Sand." The discovery of flints fractured by natural pressure at the base of the Eocene is not, however, a novel experience, as, in 1910, M. l'Abbé H. Breuil described ("Sur la présence d'Eolithes à la base de l'Eocène Parisien," *L'Anthropologie*, t. xxi., 1910, pp. 385–408) in great detail, and by means of no fewer than seventy-six excellent illustrations, a series of flaked specimens of the same kind as those now put forward by Mr. Warren. Also, in 1914, I published an account of the flaked flints occurring in the Lower Eocene "Bull-head" bed at Bramford, near Ipswich (Proc. P.S.E.A., vol. i., part 4, pp. 397–404), and gave a full account of this peculiar deposit and the nature of the fractures exhibited by some of the contained flints. It will thus be seen that this question has been fully discussed and threshed out for many years past.

Through Mr. Warren's courtesy I was enabled, before the meeting at the Geological Society's rooms, to examine his material, and I at once recognised that the flake-scars to be seen upon the specimens showed every characteristic of those produced by pressure. Though of interest as corroborating earlier finds, Mr. Warren's flints have no bearing upon the specimens discovered by me in the Sub-Red Crag detritus-bed and other ancient deposits. The flaked flints which I have collected and claimed as humanly fashioned exhibit flake-scars produced by intelligently directed blows, as is clear to anyone examining them and familiar with the obvious and fundamental differences between pressure and percussion flaking. Further, it is also clear that these pressure-fractured Eocene flints are not comparable with the specimens first found by Mr. Benjamin Harrison, which have been known by that much misused term "eoliths."

J. REID MOIR.

Ipswich, May 7.

International Council for Fishery Investigations.

THE writer (X. Y. Z.) on this subject in NATURE of April 29 seems to beat the air. There is no confusion of the general discussion with the deliberate statement of the council that "the study of the effect of the war in having closed great areas would materially assist the council in arriving at the most practical results." The closure of certain areas, for ten years or more, by the Scottish Fishery Board has already shown that such is without material effect on Nature's ways. Further, it is just the consideration of the almost valueless mass of certain statistics that, amongst other things, has led to the view that, judged by its promises and performances, the "International Council for the Investigation of the Sea," so far as the welfare of the British fisheries is concerned, is a serious waste of public money. The Development Commission's "almost judicial committee" cannot alter that conclusion.

W. C. MCINTOSH.

2 Abbotsford Crescent, St. Andrews,
May 7.

Sea and Sky at Sunset.

IN a note on the Royal Academy in NATURE of May 6 "J. S. D." expresses disbelief in the possibility that a red sunset can give rise to a pure blue colour in the sea.

Last summer and autumn I occupied a small house on the French coast near Boulogne, and I had the good fortune to witness some of the most wonderful sunsets I have ever seen. The sun used to set across the Channel immediately in front of our windows, and the light of the setting sun was reflected not only in the sea itself, but also in the pools left by the tide along the seashore.

On several occasions when the setting sun was a deep crimson in a purple sky the sea was an intense blue, while the reflection on the water suggested molten gold. The contrast between the purple and crimson of the sky and the blue and gold of the sea was very beautiful, and the effect is not one which I shall readily forget.

As the sea is never free from ripples, it is possible that some of the light reaching the eye is transmitted through the water, but whatever may be the explanation there is no doubt about the reality of the effect.

K. E. EDGEWORTH.

Crowborough, May 9.

READERS of NATURE will welcome Col. Edgeworth's description of what a sunset over the sea can be like, but those who have had an opportunity of studying the picture in this year's Academy to which reference was made will not find any difficulty in distinguishing between the reality as described by him and the artist's conception of the reality as seen at Burlington House.

As to Col. Edgeworth's description of sunsets seen over the English Channel, few who have spent holidays on a western sea-coast, or even on the reaches of a winding river like the Thames, can be unfamiliar with the pillar of gold seen in the water through the reflection of the sun's disc on the rippled surface. The golden reflection beneath the sun and the dark blue reflection beneath the sky may give rise to marked contrasts, but there is nothing unnatural in these. In the picture referred to it is far otherwise. The sun is not visible, but the whole sky is red, and where reflected light would cause innumerable spots of red upon the crests of the ripples no colour but blue is shown.

J. S. D.

Scientific Research.

IN common with other subscribers to the Scientific Research Association, I recently received an intimation from the acting secretary and the treasurer that the support accorded to it was not sufficient to justify the establishment of the proposed organisation. There can, however, be no question of the importance of the aim the association had set itself—the promotion of research, irrespective of the economic advantages it may bring with it; and it may be some satisfaction to those who feel this to know that the National Union of Scientific Workers has formed a research council to promote the interests of research for its own sake. It is desired to make this council as representative as possible of every branch of scientific investigation. Communications from all who have the success of such a movement at heart should be addressed to the secretary of the National Union, Major Church, 19 Tothill Street, S.W.1, or to myself.

JOHN W. EVANS.

Imperial College of Science and Technology,
South Kensington, May 10.

Imperial Air Routes.

RECENT long-distance flights have shown that aerial navigation is a practical means of quick transport between distant lands. The long time occupied on the first flight to Australia is no criterion of the possibilities of the future, when the route is better surveyed and adequate aerodromes replete with all facilities are established. Sir Ross Smith recently spoke of six stages, each occupying a day, as a reasonable journey from London to Sydney. Air routes promise to forge a new link in Imperial unity, and to modify to a great extent the geographical relationships of the various parts of the Empire. Until now the ocean has been the link between the home country, the Indian Empire, the self-governing Dominions, and other oversea possessions. In that respect the British Isles are centrally situated as regards routes throughout the Empire; but for flying, the position of the home country is less favourable. An uncertain climate characterised by rapid changes of weather and much fog militates against successful aviation. Moreover, land connections in provision of aerodromes are an essential in air routes.

In a recent lecture before the Royal Geographical Society[1] Maj.-Gen. Sir Frederic H. Sykes described some of the most important of the probable Imperial air routes, and showed how they naturally centre on Egypt. The flight from Egypt to India was accomplished in November, 1918, and this route is one of the first which Sir Frederic Sykes advocates developing. From Kantara to Karachi a flight should occupy 36 hours, compared with the 9 days' steamer journey from Port Said to Bombay. Baghdad would gain more, being a 12 hours' flight from Kantara, and by the present mail route 3 weeks by sea from Port Said.

In this connection it is important to realise that air traffic must pay its way if air routes are to become an established feature. Owing to the limitations in the weight that an aeroplane can carry, mails are the most suitable load. In their case also saving of time is a valuable consideration, and a return freight is ensured. Sir Geoffrey Salmond points out that the maintenance of a twin-engined machine, providing for a commercial rate of interest, works out on any route at about 10*s.* a ton per mile. An aeroplane carrying a ton, which is a fair cargo, must therefore earn 500*l.* on a 1000-mile flight, or about 1250*l.* on a flight from Egypt to Karachi. Little but mails could bear this cost, and, their carriage being a Govern-

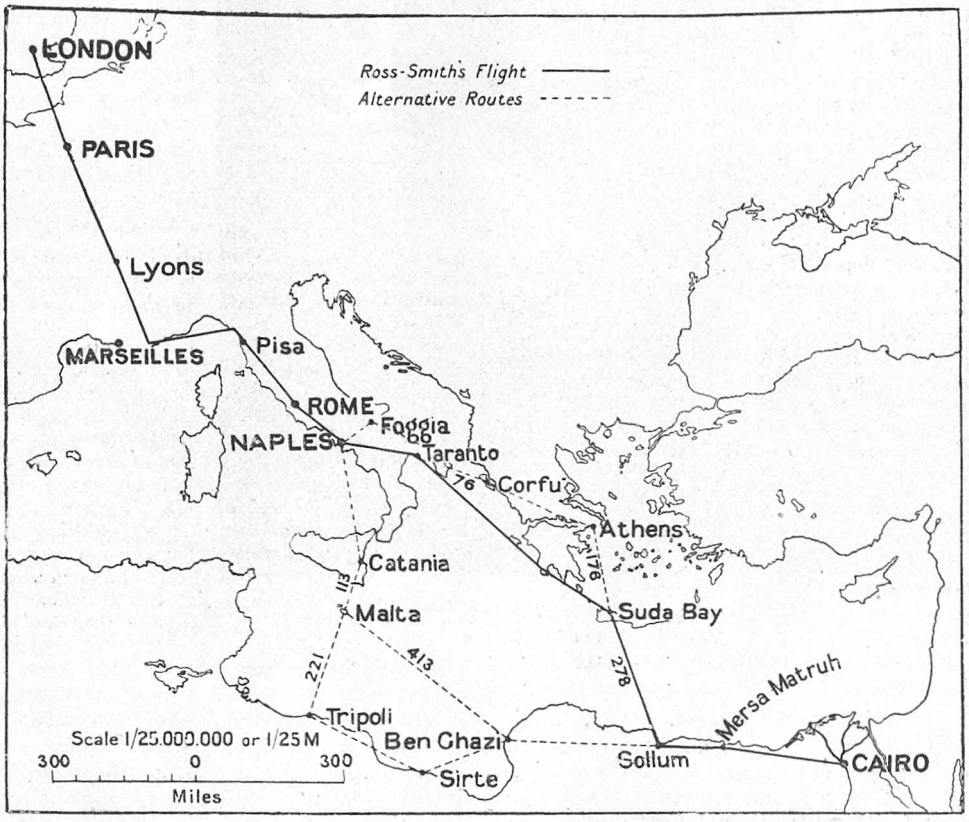

FIG. 1.—Air routes: London to Cairo. From the *Geographical Journal.*

[1] *Geographical Journal*, vol. lv., No. 4, April, 1920.

ment monopoly, could in cases of advantage be partly transferred to air routes. Speed may in time be increased in two ways—first, by the improvement of ground organisation, so as to permit night flying with a relay system; and secondly, by improvement of the engine.

Sir Frederic Sykes quotes some remarkable figures to show the comparatively small risk in flying. During the last eight months of 1919 the total mileage flown by the principal firms engaged in civil aviation was 593,000, and the passengers carried totalled 64,416. During this period only four pilots and one passenger were killed, and six pilots and ten passengers injured. This small proportion of casualties will no doubt be reduced as machines are perfected, ground organisation improved, and air surveys carried out. The close association of the Meteorological Office with the Department of Civil Aviation is a happy augury for the future, and the International Air Convention, to which most of the Allies, and several neutrals, have subscribed, should help to co-ordinate efforts in civil aviation.

The consideration of good landing-places to a large extent controls the course of air routes. From Egypt the route to India is direct from Kantara to Damascus and Baghdad, thence to Basra, Bushire, and along the shores of the Persian Gulf and Arabian Sea to Karachi. Through India two routes to Calcutta are suggested—a northern one *via* Delhi, Cawnpore, and Allahabad, which is part of the route to Australia; and a southern one by Ahmadabad, Bombay, and Nagpur. On both routes aerodromes are already built or under construction, and there is now an aerial postal service between Karachi and Bombay. The Australian route from Calcutta goes *via* Akyab to Rangoon, whence a stretch of hazardous flying over mountainous country leads to Bangkok. The route continues *via* Singapore, Java, and Dutch Timor to Port Darwin. The latter stages of the journey offer difficulties in suitable landing-places. Alternative routes are proposed, and have been partly surveyed, and it is even suggested that the use of Dutch territory might be avoided by a route from Singapore to Australia *via* Christmas Island. This would entail two stages of 810 and 950 miles respectively, to say nothing of the possible difficulties of aerodrome construction on Christmas Island.

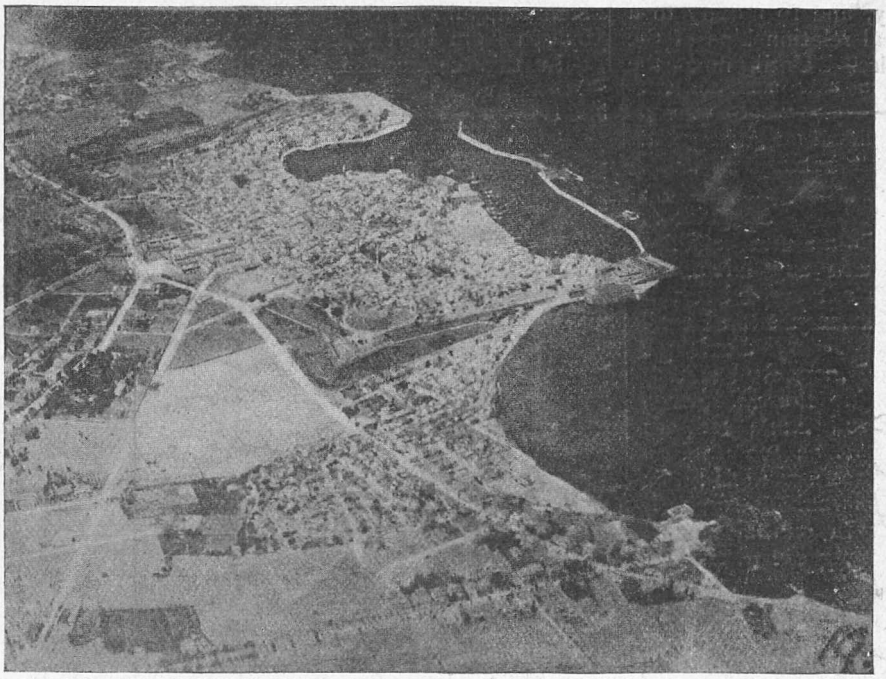

FIG. 2.—Canea from the east. From the *Geographical Journal*.

Routes from Egypt to Cape Town, and from England to St. John's (Newfoundland), Toronto, Winnipeg, and Vancouver are also suggested by Sir Frederick Sykes. The route from England to Egypt, although flown numerous times, presents difficulties, especially in Italy and the eastern Mediterranean. An alternative, but longer, route is tentatively suggested from Naples *via* Sicily, Malta, Tripoli, and the northern coast of Africa. The chief problem seems to be in the provision of a suitable aerodrome at Malta, for, once the African coast is reached, favourable conditions are found.

Helium: Its Discovery and Applications.

By DR. WILLIAM J. S. LOCKYER.

THE year 1868 is rendered memorable in the advancement of solar physics by the fact that the spectroscope was first used on an eclipsed sun. Up to that time the composition of the prominences and corona was unknown, although both these phenomena were then proved to be truly solar, the result of diligent systematic application of photography to eclipse problems since the year 1860.

On August 18, 1868, a total solar eclipse occurred in the Indian and Malayan peninsulas, lasting for about five minutes and thirty-eight

seconds. This event afforded astronomers an opportunity of applying the spectroscope, in conjunction with the telescope, to determine what the prominences were really made of. On this occasion not only were all the expeditions successful, but an almost identical discovery was also made by the numerous observers.

It was observed that the prominences gave spectra of bright lines, and, with the means of recognition available at the few moments of totality, the red, green, and blue lines which were seen were attributed to the gas hydrogen, while the strong, bright yellow line was stated to be due to the luminous emission of sodium.

During this eclipse the distinguished French astronomer, Janssen, was so struck with the brilliancy of the prominence lines in his spectroscope that he considered it certain he would be able to see the bright lines without an eclipse at all. This

It is interesting as a matter of history to refer here to the first communication which Lockyer made to the Royal Society with reference to his first successful observation.

October 20, 1868.

SIR,—I beg to anticipate a more detailed communication by informing you that, after a number of failures, which made the attempt seem hopeless, I have this morning perfectly succeeded in obtaining and observing part of the spectrum of a solar prominence.

As a result I have established the existence of three bright lines in the following positions:—

(i) Absolutely coincident with C.
(ii) Nearly coincident with F.
(iii) Near D.

The third line (the one near D) is more refrangible than the more refrangible of the two darkest lines by eight or nine degrees of Kirchhoff's scale. I cannot speak with exactness, as this part of the spectrum requires re-mapping. . . .

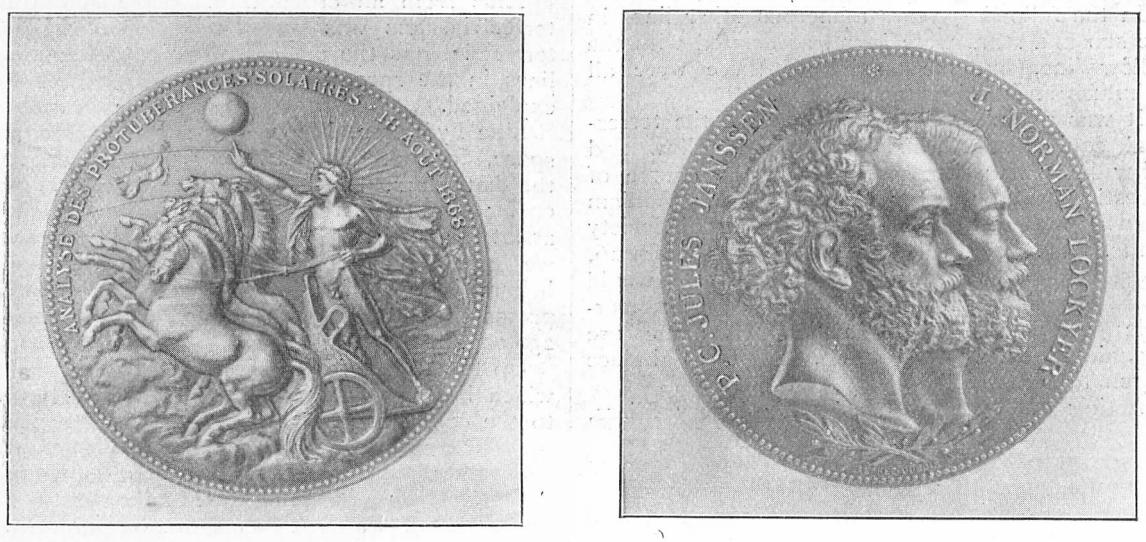

FIG. 1.—Medal struck by the French Government in honour of the joint discovery of the composition of the prominences by Janssen and Lockyer in the year 1868.

he did during the following seventeen days which he spent at the eclipse station, observing the prominences on the limb of the sun.

The achievement of Janssen was based upon principles which in 1866 had been placed before the scientific world by Sir Norman Lockyer. Owing, however, to regrettable delays in the delivery of the instrument which was ordered in the beginning of the year 1867, and being specially made for him from funds supplied from the Government Grant Committee, Lockyer did not receive it until October 16, 1868. He first used it on October 20, observing the bright lines which had been recorded in the August eclipse.

Both Janssen and Lockyer communicated the results of their discoveries to the Paris Academy of Sciences, and these despatches arrived a few minutes of each other on the same day. In honour of the joint discovery the French Government struck a special medal (Fig. 1).

From the above it will be noticed that Lockyer gives the position of the bright yellow line as near D, and not coincident with D, D being the lines of emission of sodium previously referred to.

With regard to the behaviour of this line, he states in a later communication (November 19, 1868):—

There is a line in the yellow, most probably proceeding from the substance which gives off the light at C and F, as the length of this line, as far as the later observations with the more correctly adjusted instrument go, is the same as that of those in C and F.

This statement shows that the yellow line behaved like the lines of hydrogen, and the view put forward then was that probably this line might be due to hydrogen also. The line was called D_3 to differentiate it from the double line of sodium D_1 and D_2.

A considerable amount of work was now done

with regard to D_3, for no substance was found in the laboratory which could produce this line.

By studying the behaviour of D_3 in relation to the hydrogen lines, throwing the image of the sun's limb on to the slit of a spectroscope, Lockyer found that the lines were distorted—*i.e.* there were changes of wave-length due to movements of the material in the sun. The orange line was, however, observed to behave quite differently from either of the hydrogen lines, showing that a different substance was in question.

Hence [as Lockyer remarks] we had to do with an element which we could not get in our laboratories, and therefore I took upon myself the responsibility of coining the word *helium*, in the first instance for laboratory use. At the time I gave the name I did not know whether the substance which gave us the D_3 was a metal like calcium or a gas like hydrogen, but I did know that it behaved like hydrogen, and that hydrogen, as Dumas had stated, behaved as a metal ("Sun's Place in Nature," p. 33).

In the following years numerous other lines in the sun and stars were found associated with the yellow line, but the origins of these were all *unknown* and designated as such.

It was not until the year 1895 that the terrestrial equivalent of this well-known yellow and other lines was discovered. "In the course of investigations on argon," so wrote Sir William Ramsay in a communication to the Royal Society (Proc. Roy. Soc., vol. lviii., p. 65) on March 26, 1895, "some clue was sought for which would lead to the selection of one out of almost innumerable compounds with which chemists are acquainted with which to attempt to induce argon to combine."

Acting on a suggestion by Sir Henry Miers, who directed attention to the work of Dr. Hillebrand in 1888 on the occurrence of nitrogen in uraninite, etc., Sir William Ramsay employed the mineral clèveite, essentially a uranate of lead containing rare earths. He treated this mineral, and from it extracted a small quantity of gas, which he subjected to spectroscopic examination. To use his own words, as printed in the above-mentioned communication :—

Several vacuum tubes were filled with this gas and the spectrum was examined, the spectrum of argon being thrown simultaneously into the spectroscope. It was at once evident that a new gas was present along with argon.

Fortunately, the argon tube was one which had been made to try whether magnesium poles would free the argon from all traces of nitrogen. This it did; but hydrogen was evolved from the magnesium, so that its spectrum was distinctly visible. Moreover, magnesium usually contains sodium, and the D line was also visible, though faintly, in the argon tube. The gas from clèveite also showed hydrogen lines dimly, probably through not having been filled with completely dried gas.

On comparing the two spectra, I noticed at once that while the hydrogen and argon lines in both tubes accurately coincided, a brilliant line in the yellow, in the clèveite gas, was nearly, *but not quite*, coincident with the sodium line D of the argon tube. Mr. Crookes was so kind as to measure the wave-length of this remarkably brilliant yellow line. It is 587·49 millionths of a millimetre, and is exactly coincident with the line D_3 in the solar chromosphere, attributed to the solar element which has been named *helium*.

Thus was the terrestrial equivalent of the helium line discovered after an interval of twenty-seven years.

Solar observations had shown that this line was observed high in the chromosphere, indicating that the density of the gas should be very low. Special interest, therefore, attached to the determination of this important property. In a preliminary experiment Sir William Ramsay obtained 3·9 as a maximum number for the density of helium, oxygen being 16, thus showing that the surmise was correct. Soon after this discovery Lockyer prepared some of the gas from bröggerite, and established the fact that numerous lines, designated "unknown," in the spectra of the chromosphere, nebulæ, and stars, were due to this gas.

Thus from an observation of the sun a new terrestrial gas was discovered, and from this terrestrial gas the origins of a host of unknown lines in the spectra of the heavenly bodies were explained.

Like hydrogen, helium has a wide diffusion in space, for not only is it in strong evidence in the hot stars, but it also must occur in such cooler stars as Arcturus, since this star is at about the same temperature as our sun, in which we know helium is present. In our atmosphere helium is one of the rarer constituents, being present in the proportion of about one volume in 250,000.

Up to the last few years the amount of helium which has been collected has been small, owing to the costly process of obtaining it, but during the war a demand for it in large quantities arose because of its lightness and non-inflammable nature. Helium is the lightest gas known next to hydrogen, of which it has about 92 per cent. of the buoyancy or lifting power. It was intended to supply a fleet of airships with this gas, and great fractionating plants were laid down in the United States of America capable of separating helium from natural gas at a very moderate cost. It was due to the above-mentioned demand that helium became more widely known, and attention was at once paid to bring together all the information that had been published about it as an aid to that enterprise.

The U.S. Department of Commerce took the matter in hand, and under Dr. S. W. Stratton, the director of the Bureau of Standards, a bibliography of scientific literature relating to helium was compiled. The information (more than 400 references) thus brought together has since (September 10, 1919) been published in pamphlet form in a Circular of the Bureau of Standards (No. 81), and will be found a very valuable source of reference.

The importance of helium to-day may be briefly summarised from the following extract from the introduction to this circular :—

Helium has probably been the most interesting of

all the elements to the theoretical scientist on account of the romantic history of its discovery, its occurrence in a remarkable condition of solid solution in many minerals, its formation as a product of the disintegration of the radio-active elements, its liquefaction after a decade of unsuccessful attempts by some of the world's greatest experimenters, the attainment by its use of temperatures below those at which the resistances of pure metals vanish, its many unique physical properties, and the many important theoretical conclusions which have been drawn from its behaviour.

All of these points of interest have been the subjects of very thorough investigation. The important developments of the future will probably be along the line of the applications of helium, many of which have already been suggested.

New Conceptions of Psychology.

THE results of Dr. Henry Head's clinical investigations[1] are exceptionally interesting from the philosophical point of view, for they are utterly incompatible with the older ideas of the introspective psychologists. In fact, his work is "a complete scientific refutation of all psychological theories which build up knowledge out of original sense-material" (NATURE, November 6, 1919, p. 267). Dr. Head has demolished the old psychology and created a new conception, in accordance with which "sensations depend neither for their existence nor for their psychical quality on the cerebral cortex, which has a purely interpretative function in regard to them."

The function of the cerebral cortex in sensation is to endow it with spatial relationships, with the power of responding in a graduated manner to stimuli of different intensities, and with those qualities by which we recognise the similarity or difference of objects brought into contact with the body. The old psychologists held that there was something in the external universe corresponding to primary sensations, which they regarded as being combined into the elements of perception. In accordance with such views the changes at the periphery were simple and became more complex the nearer they approached the highest centres in the brain. By submitting himself to a surgical operation in 1905 Dr. Head was able to demonstrate the complexity of the peripheral changes and the diffuseness of the impressions received. Moreover, by his clinical studies—monuments of patient research and marvellous insight—he has shown how these multitudes of diffuse peripheral changes gradually become integrated and rendered more specific in quality, space, and time as they approach the highest physiological levels in the central nervous system. The recognition of these facts gives an indication of the mode by which evolution has brought into existence such a nervous system as that of man. Lower, more impulsive, and less specific reactions become dominated by those that admit of choice. This conception turns orthodox psychology upside down.

Man's conceptions of space, time, and material rest ultimately on the nature of the spatial and temporal elements in sensation. These in turn are founded on complex physiological activities, many of which may never disturb consciousness directly; although they do not enter into the province of introspective psychology, they are responsible for much that is usually attributed to the action of the mind. Dr. Head's work on the cerebral cortex represents the culmination of an intensive investigation of the sensory system upon which he has been engaged for more than a quarter of a century. In 1893 he was studying the phenomena of the localisation of the pain associated with visceral disturbances and incidentally mapping out the distribution of the sensory nerves. Then he began the analysis of the components of the sensory nerves; and to test the problems that called for solution he invited Mr. James Sherren to cut one of the main sensory nerves of his (Head's) arm, and with the help of Dr. Rivers he studied the process of the restoration of function in the severed nerve. By this means he was able to differentiate between the three kinds of sensory nerves distributed to his arm:—

(*a*) The deep afferent system supplying the connective-tissues, muscles, joints, and tendons, in virtue of which is conferred the power of recognising movement and appreciating the position of any part of the limb, as well as of localising pressure and responding to certain aspects of pain;

(*b*) A punctate afferent mechanism in the skin, which Dr. Head has called "protopathic," the primitive nature of which is shown by the early restoration to activity (a little more than six weeks in Dr. Head's arm) of its end-organs after the nerve has been reunited, by the specific nature of the response of each set of end-organs, and by the diffuse "all-or-nothing" nature of the response, *i.e.* the absence of any graduation corresponding to the intensity of the stimulus; and

(*c*) Superimposed over this older mechanism another cutaneous system of later development and higher functions, which Dr. Head calls "epicritic." Epicritic sensibility is not restored for many months after the reappearance of protopathic sensibility, the diffuse reaction of which is then checked and controlled; and the effects of stimulation are modulated according to the intensity and locality of the exciting agent. It is concerned with the finer degrees of tactile and thermal discrimination and is opposed to, and controls, the diffuse "all-or-nothing" reaction of protopathic sensibility.

It has long been known that the sensory paths in the central nervous system had a twofold terminus, represented by the thalamus and the cerebral cortex. It remained for Dr. Head to interpret the meaning of this arrangement. He

[1] "Sensation and the Cerebral Cortex," *Brain*, vol. xli., part ii., 1918.

showed that the thalamus is concerned with the affective side of consciousness, and deals with crude awareness to contact, heat, cold, and pain; while the sensory cortex exercises the *rôle* of discrimination and endows the basic functions of the thalamus with spatial qualities, intensity and relativity.

The war afforded Dr. Head the opportunity for testing his theories as to the functions of the sensory cortex on a large scale. He made an intensive study of fifty men with strictly localised bullet wounds of the post-central convolution and the areas adjoining it in front and behind: as the result he has revolutionised our conceptions of the nature of the work of the cerebral cortex.

Destruction of the sensory cortex causes a dissociation between the spatial and the qualitative aspects of sensation. The patient loses the power of recognising movements or the posture of the affected parts: he can no longer localise the position of the stimulus, or respond adequately to variations in its intensity: he has no idea of the size, shape, weight, or texture of an object in contact with his body. Yet he can appreciate the tactile, painful, and thermal aspects of the impressions it evokes.

Thus it is possible to recognise the qualitative aspects of a sensation without of necessity obtaining any information concerning the stimulating object, as a constituent of the external world. Sensory qualities, and the affective states with which they are associated, are in themselves discontinuous. They are relative to ourselves, and appear and disappear in consciousness, without leaving any connective factor in the activities of the mind.

On the other hand, the projected aspects of sensation relate these qualities, not to ourselves, but to the external world. An "object" might be defined as a complex of projected sensory responses. These functions of the cortex are not only responsible for sensory projection in space, but also ensure recognition of sequence in time.

The power of recognising serial movements in both space and time seems to be based on the same physiological processes. They give us a direct appreciation of succession: this is translated into sensations of serial movement in either space or time, according to the nature of the concomitant sensory impulses.

These physiological responses, which are so clearly bound up with the activities of the sensory cortex, are characterised by a strict dependence on past events. All projected sensations leave behind them a coherent train of physiological dispositions: thus a movement occurring at one moment is measured against the consequences of those which have preceded it.

It is difficult to estimate the magnitude of the vast revolution in our conception of the functions of the cerebral cortex that we are witnessing. Moreover, Dr. Head's work lays the foundation of a new and true psychology and illuminates the age-long problem of the relationship of body and mind. It is a matter for just pride that we owe this new vision to an Englishman.

Obituary.

Principal R. M. Burrows.

KING'S COLLEGE and the whole University of London have suffered grievous loss by the death of Dr. Ronald Burrows. Born on August 16, 1867, Dr. Burrows went from Charterhouse to Christ Church, Oxford, with a scholarship, and took his degree in 1890 with first class honours in Classical Moderations and *Literae Humaniores*. After five years as assistant to Prof. Gilbert Murray, who then held the Greek chair at Glasgow, he was appointed professor of Greek at Cardiff in 1898, and rejoined his Cardiff colleague, Dr. R. S. Conway, as Greek professor in Manchester in 1908. By travel, during these years, in the Mediterranean, he had gained valuable experience of topography and excavation, and also that first-hand knowledge of the modern politics of Greece and the Balkan States which served him so well in later years. His published work, mainly about Greek battlefields, ancient sites in Bœotia (where he conducted most instructive excavations at Rhitsona and the Delion), and the newly revealed Minoan civilisation, gained him the degree of D.Litt. in the University of Oxford in 1910, and his "Discoveries in Crete," published in 1907, went into a third edition.

An excellent scholar, a vigorous and fluent writer, and a teacher of untiring drive and wide humanity, Dr. Burrows contributed much to "save Greek" during a difficult period by the simple and characteristic method of making his pupils interested in it, and infecting them with his own keenness; and this did not stop "out of school." His lifelong interest in young lads, and his strenuous and successful work for the Cardiff University Settlement and for the Ardwick Lads' Club at Manchester, were for him all of a piece with the "humanities" of which his Greek studies should be the crown. He enjoyed life and enjoyed people, and his sunny temper and good fellowship were the happy counterpart of his learning and judgment.

Dr. Burrows moved from Manchester to King's College as principal in 1913, at a time of crisis and manifold difficulty. Apart from other qualifications, he had, as was said, "more bishops in his family" than had all the other candidates put together, and more experience, too, than most of other "happy families" where sciences and arts could "live and let live." His width of interests and sympathies, enabling him to bring in new subjects to restore the balance between them and the old; his ready speech and debating skill; and his real grasp of principles and policies, gave him a position which experience con-

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firmed. The college organisation for modern languages, literatures, and national histories, which best commemorates him, was conceived and founded just in time for the war, which so fully endorsed his foresight and amplified his opportunities, less perhaps among the Romance languages than in the Slavonic and modern Greek departments which lay nearest to his personal interests. Knowing as intimately as he did the problems and the possibilities of the city-state world of ancient Greece, he was able in an exceptional way to interpret here the ideals, no less than the failures, of the Balkan peoples, whom he understood and impressed like the naughtier boys in his settlement clubs. Honours conferred by the Greek and Serbian Governments, and the close personal relations which he maintained with leaders such as M. Venizelos and President Masaryk—the latter one of his professors until his own country claimed him—are testimony enough on this side, and he just lived to see in the act of realisation much for which he had long striven. Such a man would not spare himself, and he would lavish help and encouragement along the whole breadth of his interests at times when only the greatest prudence could have preserved his health; but so he loved to live.

WE regret to announce the death in London on May 6 of DR. J. HAMILTON FULLARTON, so long associated with scientific fishery research in Scotland. Dr. Fullarton was born at Brodick, Arran, in 1856. He had a distinguished career as a student at Glasgow University, taking many prizes and bursaries, and graduated M.A., with the highest honours in natural science, in 1881, and D.Sc. ten years later. After acting for some years as assistant to the professor of natural history in his *alma mater*, Dr. Fullarton entered the service of the Fishery Board for Scotland as a naturalist on the scientific staff in 1889, a post which he held for eight years. On quitting the Fishery Board service, Dr. Fullarton studied medicine with a view to a medical career, and received the qualifications of L.R.C.P. and L.R.C.S.(Edin.). After serving for a short period as medical officer on an Atlantic liner, he settled in London as a consultant, and gradually built up a considerable practice. Prior to this, on the initiation of the international fishery investigations, Dr. Fullarton re-entered the service of the Fishery Board, and did valuable work for a year in the supervision of the scientific investigations on board the research steamer *Goldseeker*. It is as an expert on fisheries that he will be chiefly remembered in scientific circles. He devoted himself in particular to the study of shellfish, such as the common edible mussel, the oyster, the cockle, and the "clam," and wrote numerous papers on their cultivation and natural history. In connection with this branch of his fishery work Dr. Fullarton on more than one occasion visited the districts in France and Holland where oyster-culture and mussel-culture are principally carried on. He also made a useful series of researches on the breeding and development of the European lobster.

THE death is announced at Copenhagen of the well-known Danish philologist, PROF. L. F. A. WIMMER, at eighty-one years of age. Prof. Wimmer was the author of an important book on the Runic alphabet, "Runeskriftens oprindelse og udvikling i Norden," published in 1874, in which he suggested that the Runes were really Latin letters adapted for carving in wood, and of four volumes on Runic inscriptions in Denmark. In several of the Sagas it is recorded that Runes were inscribed on round pieces of wood, called *Kefli*, or Runic sticks. It has been suggested that the Eddas were recorded in this way, but the evidence is not quite satisfactory.

THE bearer of a name highly esteemed in botanical circles has just passed away in the person of AUGUSTIN PYRAMUS DE CANDOLLE, who died at Vallon, near Geneva, on May 9, at the age of fifty-one, surviving his father only eighteen months. The family is of French origin, but for four generations it has been settled at Geneva, adopting the local fashion of employing a capital letter for *De*. Born in England in 1869, the late botanist visited our shores on many occasions; in 1889 he came to London to receive the Linnean gold medal awarded to his grandfather by the Linnean Society of London, and in 1904 he attended the British Association meeting at Cambridge. He published but little, only about a dozen short memoirs on systematic descriptions of new plants from Madagascar and Tonquin, on parthenogenesis, and on the influence of electricity on the germination of seeds. He filled the office of president of the Société Botanique de Genève in 1905. The brilliancy of the line was shown in the great-grandfather, A. P. De Candolle (1778–1841); grandfather, Alphonse De Candolle (1806–93); and father, Casimir De Candolle (1836–1918).

BY the death, on February 27, of ALFRED J. MOSES, professor of mineralogy at Columbia University, the science of mineralogy has lost (says "H. P. W." in *Science*) one of its most eminent and valued exponents. Prof. Moses's work as a teacher, as a writer, and as a scientific investigator can scarcely be too highly esteemed, and his loss to all branches of his profession is most keenly felt. His text-book on "Mineralogy, Crystallography, and Blowpipe Analysis" will for many years remain the standard in a large majority of the universities in which courses in these subjects are given. His work on "The Characters of Crystals," published in 1899, is the first treatise published in America upon physical crystallography, a branch of crystallography which was early recognised by him as of primary importance to chemists, geologists, and mineralogists, and has within very recent years assumed a scope and developed practical applications which have more than justified his early visions of its future.

Notes.

THE general meeting of the Linnean Society on June 17 will be devoted to a celebration of the centenary of Sir Joseph Banks (1743–1820) with essays on various aspects of his life-work, and an exhibition.

DR. H. D. CURTIS, astronomer at the Lick Observatory, has been appointed director of the Allegheny Observatory in succession to Dr. Frank Schlesinger, who assumed charge of the Yale Observatory on April 1.

THE Linnean Society has elected the following as foreign members:—Prof. Gaston Bonnier, Prof. Victor Ferdinand Brotherus, Prof. Giovanni Battista de Toni, Prof. Louis Dollo, Prof. Paul Marchal, and Prof. Roland Thaxter.

THE Natural History Museum Staff Association has arranged a special scientific reunion to be held at the museum (by permission of the Trustees) on Thursday, June 3, at 3.30 p.m., in connection with the Imperial Entomological Conference. The exhibits which will be shown will illustrate some of the problems of economic interest, or arising out of the war, which have been studied at the museum during the past few years.

THE motion for the second reading of the Importation of Plumage (Prohibition) Bill was carried in the House of Commons on May 14. Lt.-Col. Archer-Shee expressed a wish to propose that it be an instruction to the Standing Committee by which the Bill will be considered to insert a schedule of the birds the plumage of which should be prohibited from importation, but the Speaker pointed out that it would be out of order to give a mandatory instruction to a Standing Committee, which could, if it wished, take such action without any instruction.

A NOTICE from the Department of Anatomy, Johns Hopkins Medical School, Baltimore, Maryland, informs us that the Ellen Richards research prize offered by an association of American college women, hitherto known as the Naples Table Association, is available for the year 1921. This is the tenth prize offered. The prize has been awarded four times, twice to American women and twice to Englishwomen. The competition is open to any woman in the world who presents a thesis written in English. The thesis must represent new observations and new conclusions based upon laboratory research.

THE medal of the Society of Chemical Industry for 1920 has been awarded to M. Paul Kestner in recognition of his distinguished services to chemical industry. The medal is awarded biennially, and among the recipients in recent years have been the Right Hon. Sir Henry Roscoe (1914), Mr. C. F. Cross (1916), and Sir James Dewar (1918). M. Kestner was born in Alsace prior to the German occupation in 1871; he was one of the chief founders and the first president of the Société de Chimie Industrielle in France, which was established in 1917. He has been connected with engineering as applied to chemical industry throughout his career, and among his more notable achievements are the use of forced draught in acid towers, automatic acid elevators, the climbing film evaporator, the scaleless water-tube boiler, and several inventions in connection with beet-sugar manufacture.

AN invitation from the Mayor and Corporation of Barrow-in-Furness to hold the annual autumn meeting of the Institute of Metals in that town on Wednesday and Thursday, September 15 and 16 next, has been accepted by the council of the institute. Particulars of the meeting can be obtained from the secretary, Mr. G. Shaw Scott, 36 Victoria Street, S.W.1, who will also be glad to forward tickets for the tenth annual May lecture, which will be delivered by Prof. C. A. F. Benedicks, of Stockholm, at 8 p.m., on June 10, at the Institution of Mechanical Engineers, Westminster, the subject of the lecture being "The Recent Progress in Thermo-Electricity." The president, Engineer Vice-Admiral Sir George Goodwin, K.C.B., will preside.

A SHORT account of the Department of Scientific Research and Experiment, which the Admiralty has set up under the Third Sea Lord, was given in NATURE of April 22, p. 245. A vote for 302,000*l.* for scientific services under the Navy Estimates was agreed to in Committee of the House of Commons on May 17. Mr. Long, in reply to points raised concerning this vote, said that after an investigation into the conditions the Government decided to ask the Lord President of the Council, who was specially charged with the care of all scientific work in the country, to set up a Committee to inquire into the whole of the work done in the Government Departments in order to prevent overlapping, and to prevent two Departments doing the same work. The Admiralty had appointed a Director of Scientific Research at Teddington, where they were going to concentrate on naval scientific research. When it came to sea-water research they proposed that that should be carried out at the sea-ports. Teddington would be carried on this year, but they hoped that before the end of that time they would have the benefit of the report of the Lord President's Committee, and they would then be in a position to avoid overlapping and duplication of work. The Admiralty would not hesitate to ask Parliament for such money as they thought necessary to give the fullest effect to scientific research and the development of the results of that research. The sum of 430,300*l.* was voted for educational services, and Mr. Long said in connection with it that the departure, taken only recently, under which reception was secured at the University of Cambridge for a certain number of naval officers as undergraduates, had abundantly justified itself. He assured the Committee that the Government is extremely sympathetic to this scheme, and hopes to increase the number of officer undergraduates.

AN interesting conference on "The Relations of the Inventor to the State," organised by the Institute of Inventors, was held at the rooms of the Royal Society of Arts on May 13. The discussion was opened by Mr. D. Leechman, who gave a good *résumé* of the present state of the patent law in the light of the new Patent Act. It was remarkable that in a meeting

of this kind the whole of the speakers were unanimous in condemning the present attitude in official circles towards inventors. It was stated by more than one speaker that those who came forward during the war with ideas and inventions that had made our success possible had not only received no reward, but had in several cases been deprived even of the merit of their ideas by officials who were themselves devoid of the necessary technical or scientific knowledge. The chairman, Mr. Walter F. Reid, stated that the working of the Royal Commission on Awards to Inventors supplied abundant evidence of the difficulty experienced by inventors in obtaining any recognition. Although large sums were now being devoted to research, he pointed out that such work was only the raw material for the development of industry; it was the application of that raw material by the inventor which resulted in the advance of industrial processes. The mass of facts as ascertained by research was already enormous; what is now required is inventive genius to make use of those facts, which Mr. Reid compared to the bricks and stones with which an architect might produce a building, but which by themselves were of little practical use.

INFLUENZA, according to the Registrar-General's return for the week ending May 1, continues greatly on the decline over the whole country, the deaths for the ninety-six great towns numbering only 202 and in London 45. For the twenty-eight weeks from October 25, 1919, to May 1, 1920, during which influenza was practically epidemic, the deaths from the disease in London were 1160, and the deaths from all causes 35,276. Deaths from influenza were 3 per cent. of the total deaths, whilst the deaths from pneumonia were 11 per cent. and from bronchitis 10 per cent. Between the ages 0 and 20 the deaths from influenza were 15 per cent. of the total, 20 to 45 years 36 per cent., 45 to 65 years 28 per cent., and above 65 years 21 per cent. The age-incidence of the deaths calculated on the total deaths for the several ages was respectively 4 per cent. for 5 to 20, 8 per cent. for 20 to 45, and 4 per cent. for 45 to 65. The insignificance of this is shown when compared with the deaths during the virulent epidemic of 1918–19, in which during thirty-one weeks from October 19, 1918, to May 10, 1919, the deaths from influenza were 47 per cent. for ages 5 to 20 of those for the corresponding ages from all causes, 52 per cent. for 20 to 45, and 22 per cent. for ages 45 to 65. During the three weeks ending April 10, the worst stage of the present epidemic, the deaths between 20 and 45, the ages attacked most severely, were only 21 per cent. of the total deaths from all causes, whilst in the epidemic of 1918–19 the deaths for ages 20 to 45 in the three weeks ending November 16, 1918, were 73 per cent. of the total at the corresponding ages from all causes. In the present epidemic deaths were most numerous during a spell of exceptionally mild weather.

A BRIEF, but very interesting, study of the pygmies of Central Africa by Mr. Herbert Lang appears in *Natural History*, the journal of the American Museum of Natural History (vol. xix.), and its value is further enhanced by a number of most excellent photographs. Anthropologists will welcome this contribution, since it summarises the results of a prolonged study of these people made during the American Museum Congo Expedition (1909–15). During that time more than a hundred life-masks, representing sixteen different tribes of Central African races, were taken. Some extremely useful observations on the physical characteristics of the pygmies are made, as well as on their mode of life, customs, and language. By way of a supplement, perhaps, to Mr. Lang's paper, this number also contains an essay on "The Pygmy Races of Man," by Mr. Louis R. Sullivan, of the Anthropological Department of the American Museum, illustrated by a number of useful tables and diagrams.

THE eighteenth annual report of the Rhodesia Museum, Bulawayo, affords instructive reading. It is evident that but for the assistance the museum is able to afford the mining industry it would cease to exist. The public generally seems to regard the institution, at most, with but a mild interest. Hence, from lack of funds, every aspect of its work is hampered. The building is all too small to house its collections, and the provision made for the storage and exhibition of specimens is utterly inadequate. It is more than probable that if a better display could be made enthusiasm might be kindled. This state of affairs is lamentable, for, as matters stand, it is impossible to secure that record of the fauna and flora of this important area of Africa which is so essential in a country being rapidly transformed by the march of civilisation. Dr. G. Arnold, the curator, is evidently having an uphill fight; but, in the interests of science, it is to be hoped that the tremendous possibilities of a well-organised museum will soon be realised.

THE Pueblo stage of culture in south-western Colorado, New Mexico, Arizona, and Utah, the domain of the cliff-dwellers, has naturally attracted much attention. The material for studying it is wide and scattered, and it is well that a competent archæologist, Mr. J. W. Fewkes, has prepared a monograph on the subject, entitled "Prehistoric Villages, Castles, and Towers of South-Western Colorado," published as Bulletin No. 70 of the Bureau of American Ethnology. The general conclusions at which Mr. Fewkes has arrived are: The buildings express the communal thought of the builders, since they were constructed by groups of people rather than by individuals. The view that either the Pueblo people were derived from Mexican tribes or, as it was customary in the seventeenth and eighteenth centuries to suppose, their descendants had made their way south and developed into the more advanced culture of the Aztecs, is not supported by architectural data observed among these two peoples; it is preferable to assume that the custom of building stone houses was not derived from any locality not now included in the Pueblo area, but that it developed as a local growth, the earliest stages, as well as the most complex forms, being of local origin. That the buildings antedate the coming of the white men is shown by the absence of mention of them in any history; no European objects have been found at the Pueblos, and the buildings and pottery have no affinity with any villages inhabited when the Spanish entered the south-west.

EXPERIMENTS with the Amphipod *Gammarus chevreuxi* by E. J. Allen and E. W. Sexton at the Plymouth Marine Biological Laboratory (*Journal of Genetics*, vol. ix., No. 4) have disclosed several mutations in eye-colour. In the wild animal the retinal pigment is black. A single individual with red eyes appeared in the second generation from animals brought into the laboratory, and the new character was inherited as a simple recessive. An albino-eyed type also appeared, in which the eyes differed in many structural features from the normal type. Another mutation, by no means uncommon, consists in the loss of the white pigment normally present between the ommatidea of the eye. This may appear suddenly or gradually, or may develop in the animals as they grow older. White-spotting also occurs on the bodies of these animals occasionally, but the rules of its inheritance show complications, and a pure spotted race has not been obtained.

IN March of 1917 the Board of Agriculture and Fisheries appointed a Committee to consider the freshwater fisheries. Attention was directed to the use of coarse fish as food, to the development of the eel fisheries, and latterly to the improvement of the salmon fisheries. Two interim reports were issued, and as a result of these the Board made an Order in March, 1918, extending, as a war emergency measure, the season of capture of coarse fish by one month. This Order was revoked in the spring of 1919. A further Order removing restrictions on eel-fishing and abolishing the close season for pike was made in April, 1918, and revoked in October, 1919. Dealing with the eel fisheries, the Committee recommended that the factory on the Severn owned by the German Fisheries Union should be taken over, and, "after prolonged negotiations," this was done. The factory exported some five millions of elvers annually to Germany before the war. Arrangements were made to carry it on, and in 1918 and 1919 about 2½ millions of elvers were distributed throughout this country. The Committee hopes this work may be continued regularly. In its final report, now published, practical methods of eel cultivation are dealt with, and the necessity for investigation into the biology of freshwater fishes in general is discussed. Recommendations are made with regard to the pollution of rivers, improvements of the latter as breeding-grounds, and the consolidation of the law as to fresh-water fisheries. Practical suggestions for the cultivation of carp are given in an appendix.

MR. W. B. WRIGHT, of the Geological Survey of Ireland, has made "An Analysis of the Palæozoic Floor of North-East Ireland, with Predictions as to Concealed Coalfields" (Sci. Proc. R. Dublin Soc., vol. xv., No. 45, 1919, price 1*s.* 6*d.*). Mr. Wright accompanies his careful reasoning as to the synclines and anticlines produced by the Armorican and later foldings by a coloured geological map showing the intersections of two systems of folds, and therefore the probable domes and basins. He relies much on the repetition of similar fold-features in the same area during successive geological periods—that is, on the principle of posthumous folding on which R. A. C. Godwin-Austen based his prediction of the Dover coalfield. It is no secret that the deep boring put down recently by the Ministry of Munitions on the west shore of Lough Neagh in accordance with the arguments of Mr. Wright has more than proved his main contention, the Carboniferous rocks, on the line of the Armorican syncline of Central Scotland, having been carried down by Cainozoic sinking to depths completely unexpected.

THE issue of the *Revue scientifique* for February 14 contains Prof. G. Friedel's opening address on his installation in the chair of mineralogy at the University of Strasbourg. Prof. Friedel, himself an Alsatian by birth, looks forward to the development of research in a university that will never become the slave of politics or the mere servant of industrial ideals. He says finely: "La science n'est pas la servante de l'industrie, elle en est la mère." His address deals with the insight given by the use of X-rays into crystalline and molecular structure, and he describes the work inspired by Laue, of Munich, in 1912 as "la plus belle assurément et la plus riche en promesses de la cristallographie récente." In the developments made by Sir W. H. and Prof. W. L. Bragg he perceives the end of our conception of the existence of molecules as such within a crystal, and a realisation of the crystal as one enormous molecule, in which the grouping of the atoms does not permit of a division into similarly constituted particles corresponding with the molecules of the chemist.

WE have received from Koninklijk Magnetisch en Meteorologisch Observatorium, Batavia, the volumes of rainfall records in the Dutch East Indies for the years 1915, 1916, and 1917 (Regenwaarnemingen in Nederlandsch-Indië). The records are remarkably complete, and comprise data from several thousand stations scattered throughout the islands. There is no discussion of the data, but the volume for 1915 gives the mean of more than three hundred stations for the period 1879 to 1915. The same volume gives useful notes on the position and equipment of the various stations.

THE Koninklijk Nederlandsch Meteorologisch Instituut has published the first part of an oceanographical and meteorological folio atlas of the Atlantic Ocean under the editorship of Dr. E. van Everdingen, director of the institute. The present part covers the months of December, January, and February, and is based on observations from 1870 to 1914. It follows the lines of the previous work on the Indian Ocean, and utilises mainly the observations of Dutch vessels, but these are supplemented by data from the Meteorological Office, London, and the Deutsche Seewarte. Maps for each month show the distribution of wind, currents, sea- and air-temperature, cloudiness, and floating ice. The volume of data which was to accompany the atlas has been delayed in publication.

THE current (April) part of the Proceedings of the London Mathematical Society is of melancholy

interest because it contains the conclusion of the late E. K. Wakeford's paper on canonical forms. The paper is remarkable for its generality and the simplicity which it gains by the use of the theory of apolarity. Moreover, certain results follow almost intuitively from known geometrical facts, *e.g.* the general ternary quartic cannot be expressed as the sum of five fourth powers, *because* the square of the conic through five points may be regarded, in this connection, as a quartic with double points at all of them. This example is interesting historically, because the original (and different) proof of the theorem in question was one of the first to show the untrustworthiness of the method of counting constants. Wakeford's premature death will be deplored by all who can appreciate the brilliance and originality of his work.

THE April issue of the Journal of the Röntgen Society contains the communication made to the society at a recent meeting by Prof. E. T. Jones on the action of the induction coil. By means of an electrostatic oscillograph Prof. Jones has investigated the effects on the potential of the secondary of the coil, both on open circuit and when connected to an X-ray tube, of changes in the capacity of the condenser shunting the break, and in the degree of coupling between the primary and secondary of the coil. He finds that the effects correspond closely with those to be anticipated on the theory that in the secondary on open circuit the potential after break consists of two component waves, which begin in opposite phase and have amplitudes inversely proportional to their frequencies. He considers that induction coils can be further improved by investigating and reducing the losses in the iron cores of the coils, by introducing interrupters which will break stronger currents without such large capacities in parallel with them, and by determining the best method of adjusting the coupling between the primary and secondary, either by alteration of their relative lengths or widths or by other means.

A VERY interesting example of the progress which has taken place during recent years in electric power supply is presented in a paper by Mr. J. S. Watson read on April 30 before the North-East Coast Institute of Engineers and Shipbuilders, in which he gave a brief historical sketch of the development of the generating stations of the Newcastle-upon-Tyne Electric Supply Co., the principal pioneer of electric power supply on a large scale in this country. Dividing the twenty-nine years of this company's activity into stages, Mr. Watson traced the progress from a small station with 2400 kw. in 200-kw. units to the latest addition, the Carville "B" station, with its five 10,000-kw. turbo-generators. Among the many important features referred to is the gradual decrease in steam consumption per kw.-hour from 28·5 lb. to 10 lb. An equally interesting comparison lies in the plant capacity per square foot of floor-space occupied, which is 15 kw. as against 0·3 kw., and other figures showing gain in economy are those of kilowatt capacity per man employed in the station—633 kw. and 141 kw. respectively. These improvements are attributable mainly to increases in boiler pressure, steam temperature, speed of revolution and size of unit, and to more complete utilisation of labour-saving appliances. Another no less important feature of the scheme is the running in parallel with the steam-driven stations of "waste-heat" generating plants at various points on the network utilising on a considerable scale by-product energy from coke-ovens and blast-furnaces.

IN a paper on the economics of the petroleum industry read recently by Mr. R. S. Dickie at the Imperial College of Science and Technology, there appears a series of well-justified criticisms relative to the geological, chemical, and engineering procedure of the producing companies. Such subjects as the proper spacing of well-sites, the economical utilisation of fuel by the provision of heat and cold interchangers, the preposterous waste in the current use of boiler-stills, the insufficiency of our present knowledge of lubrication and lubricating oils, the need for research on blended motor-fuel, and the possibilities of recovering valuable components from the crude oil by methods other than distillation were briefly touched upon. Among the more interesting statements made is the following: The greatest producing well is No. 4 Potrero del Llano (Mexican Eagle Co.), which ran wild for ninety days, flowing at the rate of 100,000 barrels per day. In the eight years of its life it produced 100,000,000 barrels of oil (1 barrel = about 45 English or 50 U.S.A. gallons).

WE have received from Messrs. A. Hilger, Ltd., 75A Camden Road, N.W.1, an attractive catalogue of their well-known wave-length spectrometer with high resolving power accessories, including the Lummer-Gehrcke parallel plate, the Fabry and Perot etalon, and the Michelson echelon diffraction grating. At a time when the structure of spectra is receiving so much attention from physicists it is good to know that a British firm can still assist in supplying the very necessary "munitions" in the form of efficient scientific apparatus. As is well known, this firm has been able very largely to control the effects of lack of homogeneity in glass by interferometer methods, which should considerably improve the performance of such instruments.

READERS of NATURE in search of book bargains should obtain and consult Catalogue No. 187 just issued by Messrs. W. Heffer and Sons, Ltd., Cambridge, in which some 331 books in new and perfect condition are listed at greatly reduced prices. Among the works relating to science we notice the "Scientific Papers" of Prof. J. C. Adams; sets in different bindings of "Biologia Centrali-Americana," also separate sections of the work; Prof. J. Stanley Gardiner's "The Fauna and Geography of the Maldive and Laccadive Archipelagoes"; Hagen's "Atlas Stellarum Variabilium"; Hewitson's "Exotic Butterflies" and "Illustrations of Diurnal Lepidoptera"; Leech's "Butterflies from China, Japan, and Corea"; and a set of "The British Bird Book," edited by F. B. Kirkman.

Our Astronomical Column.

A BRIGHT FIREBALL.—A splendid meteor was seen on May 9, 9h. 10m. G.M.T., from Bristol, Cardiff, London, Weston-super-Mare, and other places. Special interest attaches to the object, for it appears to have descended to very near the earth's surface, if, indeed, it did not actually fall to the ground. The meteor traversed a path of about 60 miles in 5½ seconds, and fell from a height of 54 to 12 miles. Combustion occurred over Radnor Forest, and the meteor apparently disappeared over a point 10 miles east of Barmouth. If the object was enabled to travel in a compact form about 15 miles further, it must have alighted on the ground in the region some ten miles south of Bangor, Carnarvonshire, but no intimation has yet been received that a meteorite has been found, or was seen to fall, there.

CONJUNCTION OF MERCURY WITH ε GEMINORUM.—Mr. A. Burnet, of Oxford University Observatory, makes a special study of occultations of stars by planets. He now points out a close approach of Mercury to the third-magnitude star ε Geminorum on June 11. The position of the star is R.A. 6h. 39m. 1·73s., N. decl. 25° 12′ 33·8″. Mercury is in the same R.A. at 9h. 7m. G.M.T., 14″ south. The semi-diameter and parallax are 2·9″ and 7·7″, so that an occultation will not happen at any part of the earth. The hourly motion of Mercury is +19·4s., S. 55·8″. Hence conjunction in declination occurs at 8h. 52m. Micrometer measures of the differences of R.A. and declination of planet and star will be of value, especially as Mercury is a difficult object to observe on the meridian. The sun sets in London at 8h. 14m., and Mercury at 9h. 50m. The times throughout are given in G.M.T., not summer time. It is rather unfortunate that the date coincides with that of the Royal Astronomical Society's meeting, as that will prevent some astronomers from observing it.

LONGITUDE BY WIRELESS TELEGRAPHY.—This subject was discussed at the geophysical meeting at the Royal Astronomical Society on May 7. Prof. Sampson, Astronomer-Royal for Scotland, pointed out that wireless telegraphy supplied the long-sought desideratum of signals that could be received simultaneously over the greater part of the earth's surface; in the past eclipses of the moon or Jupiter's satellites, lunar distances and occultations had been employed, but the new method gave far higher accuracy. He formulated a scheme in which three observatories at longitudes some 120° apart, or, if preferred, four observatories 90° apart, should each receive the signals of suitably placed wireless stations and note their local time in the usual manner by meridian observations. The method would determine both the longitudes of the stations and the periodic errors in the assumed clock-star places, since different clock-stars would be on the meridian of each observatory at the time of each signal. No extreme accuracy is called for in the time of sending out the signal, since the method is wholly a differential one. Interchange of observers is not contemplated; this has hitherto been the practice in longitude determinations, but the new method contemplates using the ordinary observations with the standard instrument of each observatory for a considerable period. There will thus be several observers, and if the travelling-wire method is adopted very little error will be introduced by personal equation. Plans are already far advanced for connecting Greenwich with Sydney in this manner.

A demonstration was given of the method of recording the wireless signals on a chronograph by the use of a Fleming valve. The ticks of a chronometer, transmitted by a microphone attached to the glass, were simultaneously recorded. The chief difficulty was stated to be not the weakness of the transmitted wireless signal, but the frequent confusion produced by atmospherics.

Periodicity in Weather and Crops.

IT is generally understood that the principal source of terrestrial weather changes is to be found in solar radiation. Inasmuch, therefore, as the yield of crops depends very largely on the weather, it is quite natural to assume that any periodicity in the solar radiation is likely to be reflected in the world-harvests and the price of food. Many investigations have had for their object the testing of a direct correlation between solar activity, as evidenced by sun-spots, and such terrestrial phenomena as the Indian monsoon in regard to drought and famine. The mechanism of world-weather is exceedingly complex, but progress is steadily being made in elucidating the cause of the numerous departures from obedience to any simple general law.

The next step, after comparing terrestrial phenomena with the known sun-spot period, was to analyse various sets of data in search of unknown periodicities, and Prof. Turner, for example, goes so far as to connect what he calls "chapters" of meteorological history with the movement of the earth's pole that produces latitude variation. There is, however, one very great difficulty in fixing any period the physical basis of which is unknown, and that is the incommensurability of all the suggested periods with that of the earth's revolution round the sun. It is obvious that a dry period occurring exactly at sun-spot maximum, for example, if such a phenomenon should be persistent, and if, which is another difficulty, the sun-spot maximum were an exact predictable moment, would have a totally different influence on the harvest according to the time of year at which the drought occurred. The effect would also be quite different in different parts of the world, notably on the two sides of the equator.

On Wednesday, May 12, Sir William Beveridge, Director of the London School of Economics and Political Science, delivered a lecture on the subject of a hitherto unrecognised periodicity in the weather and the crops. From the *Times* report of the lecture we gather that he rather discredits the "sun-spot" influence, at least in the form advanced by Prof. Jevons nearly half a century ago, and produces ostensibly consistent evidence in favour of a period of 15⅓ years during the past three centuries. The argument rests upon historic records of poor harvests, of Indian famines, of tropical droughts and equally disastrous wet summers in higher latitudes, and also to a great extent upon official statistics of food prices.

There is no indication in the report that attention was paid to such obvious matters as war and plague, which would have an enormous effect on prices. The meteorologists of the next century will not, we hope, attribute the high prices under which we are now suffering to a periodic meteorological influence. Sir William Beveridge has succeeded in setting forth a list of dates at approximately equal intervals, and claims that every one corresponds to a period of high prices. He admits that there were other times of similar conditions not belonging to the series he claims to have discovered, and he also allows an occasional uncertainty of something less than five years, but he warns us to expect most unseasonable weather, bad harvests, and high prices, with possible famines, in one or more of the years 1924, 1925, and 1926.

From the summary of the evidence produced it is quite possible to extract some comfort. Sir William Beveridge's appeal to the barometer makes it clear that he regards a low mean annual pressure as a direct indication of bad harvests, and points to the years 1878, 1893, and 1909 as the three years of lowest pressure in a forty-year period over the greater part of the habitable globe. It is, on the face of it, practically impossible that the pressure over the whole earth should vary from year to year; so perhaps we are to assume a higher selective pressure over the ocean areas in such years. In any event, we were very fortunate in this country in 1893 with a glorious summer, shared also by France, in spite of the world-conditions. There is another aspect which must not be ignored, and that is the physical basis on which the period depends. The lecturer contented himself with suggestions of a combination of periods of shorter length, hinting that $15\frac{1}{3}$ years is a sort of least common multiple of two or more of these. The actual figures given are, however, singularly unconvincing. Sir William Beveridge mentions a meteorological period of just over five years, without any details in support of it, and couples this with "the important $2\frac{3}{4}$-year cycle." Is this a period in itself, or is it merely one of the harmonics of the 11-year sun-spot period? He says eleven of these make two of his $15\frac{1}{3}$-year periods; so if the $2\frac{3}{4}$-year period is really "important," his new one should be $30\frac{2}{3}$ years. What *is* apparently important, as we remarked before, is the 12-month period, and this would indicate 46 years as a super-period, but there is no indication of any specially bad harvests at every third period in his table.

Sir William Beveridge's forecast for 1924–5–6 is given with some diffidence, showing that he is not too confident of the reality of the period, and it is not likely that he has made much impression on the devotees of the sun-spot period, which has been claimed to show direct correlation with such different phenomena as the price of wheat and the number of fellows of the Royal Astronomical Society.

One last question we might raise is: Does fine weather necessarily mean lower food prices, considered in the light of the suggestion that strikes and labour unrest are generally regarded as fine-weather phenomena? W. W. B.

The National Food Supply.

SIR DANIEL HALL, in the first of his three recent Chadwick public lectures on "Gardening and Food Production," dealt with the national food supply and the possibility of self-support. According to the values obtained by a committee of the Royal Society for the five-year period prior to the war, only 42 per cent. of the total food supply consumed in the United Kingdom was produced at home. At the beginning of the nineteenth century the country was practically self-supporting, but since that time the population has greatly increased, while the productivity has decreased. In 1872 there were 14 million acres under the plough in England and Wales, but by 1914 nearly 4 million acres of this land had been put down to grass. Grass land is comparatively unproductive of food as compared with arable land, for, according to Sir Thomas Middleton's calculation, 100 acres of arable land in this country normally produce food that will maintain eighty-four persons, whereas the same 100 acres under grass will maintain only fifteen to twenty persons. The great difficulty is that arable land requires much more labour than grass land, and farmers naturally refrain from ploughing up their land when the cost of labour has risen very much more than have the prices of the produce. In 1917–18 another $2\frac{1}{2}$ million acres were added to the acreage already under the plough, but the food crisis is not yet over. It is essential that we should increase our productivity, and to attain this end we must agree to pay the prices necessary to make arable farming reasonably profitable to the farmer. Moreover, the population will have to change its habits and eat more bread, potatoes, etc., than meat, while pork will have increasingly to replace the more expensive animal foods.

The second lecture was concerned with the development and uses of allotments. The history of allotments appears to go back to a very early date; for from the time of Henry III. onwards there are statutes dealing with pieces of cultivated land of the allotment type. The first period of active growth of the allotment scheme was in the nineteenth century, when the industrial system and the large towns developed. A noteworthy example is the still flourishing group of allotments started by the late Sir John Lawes on his Rothamsted estate, in connection with which a club-house for the use of the allotment-holders was built as early as 1857. Without doubt the greatest extension of the allotment movement occurred during the years 1916 onwards, when the country was threatened with a serious food shortage. At the present time it is estimated that about one million allotments are in use. The typical allotment of one-sixteenth of an acre is rarely capable of providing all the potatoes and vegetables needed by an ordinary small household, but when a million of such allotments are considered, it is clear that they do bring about a marked saving in the national food bill. Unfortunately, the typical allotment is not always cropped to the best advantage, but it is hoped that this will be improved through the publication of a detailed scheme for allotments by the Ministry of Agriculture. In dealing with fertilisers the lecturer pointed out that many allotments are deficient in humus, and must be supplied with stable manure in addition to artificial fertilisers. Town-dwellers are faced with further difficulties over the tenure of their allotments, but it is hoped that all building schemes in the future will provide for a reasonable amount of allotment land.

"Social and Hygienic Conditions Respecting Gardens and Allotments" provided the subject for the third of Sir Daniel Hall's lectures. Under this heading was discussed the extreme importance of "vitamines," of which three at least have been found to be present in food. These vitamines occur mostly in living plants, although they are found also in certain animal foods. They are essential for the healthy development of human beings. In this connection appears one of the great values of allotments, for by their means a large number of people are provided with fresh vegetables containing the all-important vitamines, without which various diseases are liable to occur. The lecturer next dealt with the social value of allotments. Passive amusements, such as picture palaces, etc., fail to satisfy completely one's need for amusement, but there is enormous satisfaction in growing things; moreover, some of our best varieties of flowers and vegetables are the result of the efforts of working-men, who found much to interest them in the allotments which provided a welcome diversion from work that was often monotonous and carried out under unpromising conditions. The growth of the allotment movement will surely put men on a sounder economic basis, in addition to providing an active interest in life and to ensuring the better health of their families.

The Research Associations.

NOTHING could be more satisfactory than the account that Dr. A. W. Crossley gave on Friday last to the Conference of Research Associations of the constitution and methods of the British Cotton Industry Research Association, of which he is director. It embraces every activity that contributes to the production and utilisation of cotton, and represents more than 95 per cent. of the firms engaged in the industry. Among its members are some of the Labour leaders, and these take the keenest interest in its work. It aims to obtain, in the first place, more exact knowledge of the chemical and physical properties of the fibre and the scientific facts which lie at the base of the processes employed; for it is considered that it is only in this way that the true solution of the problems which present themselves can be assured. It is to be hoped that the same broad and scientific spirit may animate all the associations that have been formed under the Department of Scientific and Industrial Research.

It appeared to be generally agreed that one of the most important conditions of the success of the movement was its close association with the universities and colleges where scientific research has hitherto been mainly carried out. It is to them that research associations and the research departments of private firms must look for their supply of science workers, and it is obviously important that those who are engaged in preparing men and women for the task of industrial research should be acquainted with the lines on which it is carried on. It is for this reason to be desired that the scientific staffs of these institutions should take their share in the technical research required by our industries, and it is a matter of congratulation that the Imperial College of Science and Technology has already led the way in this direction. Lord Crewe, who presided, referred in this connection to the "industrial fellowships" established at Pittsburgh and elsewhere in the United States to facilitate the investigation of technical problems. The work is carried out in close co-operation with the universities, and at the joint expense of the manufacturers concerned and of the endowment.

The question of the publication of the results of industrial research presents serious difficulties. As Dr. Crossley remarked, those employed upon it must keep in close touch with those engaged in pure research, on whose conclusions their work is based, but they cannot be always taking without giving something in return. He urged that a large proportion of the work carried out should ultimately be published even if for commercial reasons it had to be held back for several years; and Dr. Lawrence Balls reminded the conference that the stimulus of the prospect of future publication was required to secure the accurate record of the data obtained in the course of a research.

Not less important are the closely allied questions of the remuneration and superannuation of the scientific workers employed by the associations. This was discussed by Mr. J. W. Williamson in an interesting paper. He came to the conclusion that under present conditions 400*l.* per annum is the minimum that should be offered to a science graduate who has already had two or three years' training in research. He pointed out that a post under a research association did not afford the same security of tenure as one at a university. The desirability of extending to the staffs of research associations the federated superannuation system for universities was acknowledged on all sides. J. W. E.

Solid Lubricants.

ALTHOUGH the report of the Lubrication Committee has not yet been issued, a "Memorandum on Solid Lubricants," prepared for the Committee by one of its members, Mr. T. C. Thomsen, has recently been published (Bulletin No. 4 of the Department of Scientific and Industrial Research Advisory Council). This pamphlet of twenty-eight pages contains a digest of the existing knowledge in this branch of the subject, and will be found most useful to all engineers and users of machinery. The solid lubricants referred to are natural and artificial graphite (which are by far the most important), talc, mica, and such substances as flowers of sulphur, white lead, etc., which are occasionally used for curing hot bearings. The greater part of the bulletin is concerned with graphite, and although there is not much matter which is new, there is a great deal of information which will be of interest to many users of lubricants. The action of solid lubricants and the conditions under which they can be usefully employed are clearly explained.

The natural graphite used for lubrication is usually of the flake variety, and varies in the size of its particles from 1/10 in. to less than 1/200 in. The lubricating graphite produced artificially is amorphous. It is ground even finer than the natural graphite, and by chemical treatment is further reduced to particles of colloidal dimensions and sold under the tradenames of "Aquadag" and "Hydrosol" when in admixture with water, and "Oildag," "Oleosol," and "Kollag" when in admixture with oil. Analyses of the different varieties of lubricating graphites are given in the pamphlet, and it is seen that some are almost chemically pure carbon, whilst others contain mineral matter in variable proportion. Solid lubricants are applied dry in cases where for special reasons it is inadvisable or impossible to use liquid or semi-solid lubricants, but they are usually employed in admixture with oil or as an ingredient of greases. When mixed with oil ordinary graphite settles out, owing to its high specific gravity. Colloidal graphite does not settle so long as the vehicle remains neutral, and is carried with oil through the finest orifices, even through worsted trimmings, but it has the disadvantage of being easily caused to coagulate in presence of acid or alkali.

"Oildag" and "Aquadag" have been on the market for a number of years, and the experiences of users of these and other forms of graphite which Mr. Thomsen has collected for general information will be found of considerable value. Perhaps the most interesting experience is that of Mr. E. W. Johnston, who has successfully employed "Aquadag" as a cylinder lubricant and eliminated all the trouble caused by the presence of oil in condensed steam. Experiments made at the National Physical Laboratory showed that the addition of "Oildag" to mineral lubricating oil was advantageous where solid friction occurred, as in worm gear, but quite as good results were obtained with natural flake graphite, so that the lubricating value of graphite seems to depend upon its chemical purity, and the special advantage of the colloidal graphite is due to its property of remaining naturally suspended in the liquid medium without requiring to be stirred constantly by artificial means. The remarks on the use of graphite in internal-combustion engines, in the lubrication of ropes and chains, and in metal-cutting and wire-drawing will be found of great interest and practical use.

All who are interested in lubricants should obtain a copy of this pamphlet, which can be purchased through any bookseller for sixpence. L. A.

Greek Science and Philosophy.

ON Wednesday, May 12, Dr. C. Singer delivered his inaugural address as lecturer in the history of medicine at University College, London. Sir Robert Hadfield presided over a large and distinguished audience. After alluding to the neglect of the history of science in this country, Dr. Singer referred to the organised effort now being made by Dr. Wolf and others to remedy it at University College. The institution in which Augustus De Morgan spent the whole of his active life was a peculiarly appropriate place for such an experiment. The history of science was a necessary element in any curriculum that sought to give a view of the mental history of the human race. Turning to the various stages through which science has passed, Dr. Singer made some interesting comparisons between the science of the ancient East, the science of Greece, and modern science. Among the characteristics which distinguished Greek science from Oriental science and allied it to ours were the individuality and eponymity of its discoveries, as distinguished from the anonymous thought of preceding civilisations, which always appeared as a social rather than as an individual product. Another and more important feature of Greek thought was the conviction of the reign of law, the idea that order rules in Nature. This belief, almost an article of faith with the Greeks, has been justified more and more with the advance of natural knowledge. On the other hand, Greek science differed from ours in various ways. The most obvious difference was the intimate relation between Greek science and Greek philosophy. This was due to the fact that Greek science was originally a department of Greek philosophy. The divorce between our science and philosophy had many advantages, but also some drawbacks. Another important difference between Greek and modern science is to be found in the method of record. The Greeks were interested in results rather than in methods, and almost always neglected to give an account of their methods. As a consequence, their results cannot be relied upon, and, except by hard research, we can get no glimpse of their methods of working. The mathematical group of sciences, however, formed an exception in this respect. In these the Greeks recorded their methods as well as their results.

Life-history of the Periwinkle.

UNTIL 1908 the life-history of the common periwinkle, *Littorina littorea*, L., was unknown. In that year Dr. W. M. Tattersall published a brief announcement of some investigations made that included the discovery of its ova. He reserved a more detailed account until further observations and researches could be carried out, but this proved impracticable, and Dr. Tattersall has now issued the notes of his work so far as it went (Department of Agriculture and Technical Instruction for Ireland (Fisheries Branch), Scientific Investigations, 1920, No. 1, pp. 11, 1 plate), being largely instigated thereto by the publication in 1911 of a paper on the same subject by MM. Caullery and Pelseneer. From Dr. Tattersall's account it appears that the breeding season lasts from the middle of January to June, and the pink eggs are enclosed singly or in pairs (sometimes three and exceptionally four) in small, curiously shaped, transparent capsules resembling a soldier's "tin" hat, the eggs occupying the crown. These capsules are unattached, and vary from 0·6 to 0·9 mm. in diameter, the eggs being from 0·15 to 0·16 mm. Segmentation is completed during the first day, and at the third day the circumoral ring of cilia is complete and the embryo begins to rotate. At the sixth day the embryo breaks out from the capsule and swims freely about in the water. The chief food of *Littorina littorea* appears to be the hyphal hairs of *Fucus serratus* and allied seaweeds, and the animal swallows indiscriminately the diatoms and other microscopic organisms clinging to the seaweed. The climbing habits of these molluscs suggested to the author the possibility of establishing "farms" for their more easy collection for the market. Experiments were made by erecting stakes in their intertidal haunts, but, though the snails of all ages would ascend, they seemed incapable of retaining their hold save in calm weather, hence the farming had to be abandoned. In conclusion, the author advocates the grading of the winkles into sizes before dispatching them to market, using two sieves of $\frac{3}{4}$ in. and $\frac{5}{8}$ in. respectively, and rejecting all that pass through the smaller as unmarketable.

The Royal Society Conversazione.

THE first of the two annual conversaziones of the Royal Society was held at Burlington House on Wednesday, May 12, when the president, Sir Joseph Thomson, received a large company of fellows of the society and other workers of distinction in the scientific world. As is usual upon such occasions, many exhibits of recent methods and results of investigation were displayed, and much interest was taken in them. Mr. A. A. Campbell Swinton gave a most successful demonstration and exposition of wireless telephony with apparatus supplied by the Marconi Wireless Telegraph Co., Ltd. Gramophone records and musical instruments played at the company's works at Chelmsford were loudly reproduced in the meeting-room of the society. The apparatus used consisted of an amplifying detector and note magnifier, to which was connected a loud-speaking telephone enabling speech to be heard distinctly over the whole ground floor. The aerial consisted simply of a frame 3 ft. square, wound with a few turns of wire, and placed on the lecture-table in the meeting-room. The subjoined descriptions of most of the exhibits, arranged so far as possible in related subjects from man to machine, are abridged from the official catalogue:—

Mr. M. C. Burkitt: (1) Tracings of prehistoric rock engravings from the shores of Lake Onega, North Russia, the only site in Russia west of the Urals where prehistoric engravings occur. (2) Palæolithic stone implements from North Africa, showing that there is a series comparable in general form with the regular sequence in France and Britain.

Mr. S. H. Warren: Specimens from a factory of Neolithic stone axes at Graig-lwyd, Penmaenmawr. The axes were made from the scree which fell down the mountain-side from a line of crags formed of the fine-grained (chilled) margin of the Penmaenmawr intrusion. Axes are found in every stage of manufacture, discarded on account of breakage or unsatisfactory shape, the most frequent fault being excessive thickness of blade. Palæolithic resemblances are abundant and striking.

Mr. L. Treacher: A large Palæolithic implement from the Gravel at Furze Platt, near Maidenhead. The gravel in which this implement was found has also yielded a very large number of palæoliths, mostly belonging to the Chellean type, although a few Mousterian flakes have been found. The surface level is

about 140 O.D., being 20 ft. lower than that of the Boyn Hill terrace in the neighbourhood.

Mr. Herbert Bolton: Enlarged photographs of fossil insects from the British Coal Measures. The first recorded fossil palæozoic insect from any country was discovered in the Coal Measures of Coalbrookdale in the early part of last century. In 1908 only twelve additional types from Great Britain had been made known. Mr. Bolton's researches during the last ten years have revealed the fact that at least fifty distinct types had lain unrecognised in various museums and private collections. The photographs exhibited were made by Mr. J. W. Tutcher.

Dr. W. K. Spencer: Palæozoic starfish and their habits. Recent work by the Danish Fisheries Board upon the habits of recent forms throws considerable light on the mode of life of the fossil starfish. Recent starfish can be divided into (1) starfish, carnivores, and (2) brittle starfish, detritus feeders living on vegetable remains in the mud on the sea-bottom or on very young marine animals. Both these series of forms are modified for their respective mode of life. The exhibit showed that both classes of forms were present in the palæozoic rocks, and that some of the forms from the very old rocks were strikingly similar in mode of life to those of the present day. Forms which are transitional in structure between the two series were also shown.

Dr. F. A. Bather: Stalked Echinoderms with a horizontal habit of growth. In a normal stalked Echinoderm the stalk, body, and five arms are symmetrical about the long axis, which is vertical, and the waste products are carried away from the vent at the upper end. But all the Cystids found in the Upper Ordovician starfish bed of Girvan, Ayrshire, have a body flattened in the plane of the stalk, and this shows that the long axis was stretched horizontally. Extreme modification for this mode of life is reached in three different ways by three genera of diverse origin: Dendrocystis, which floated, with its stalk attached probably to seaweed; Pleurocystis, which was possibly attached, but rested its body on the sea-floor; and Cothurnocystis, probably free, with its body resting on the sand by short legs. Cothurnocystis had no arms, but from thirteen to forty-two mouth-slits.

Mr. R. D. Oldham: Model to illustrate an hypothesis of the origin of mountains. If the variation in density, and consequently in bulk, of the matter underlying mountain ranges is also the cause of the surface elevation, and if the outer crust is possessed of a considerable degree of strength and stiffness, resting on material of a more yielding character, systematic departures from complete equivalence of surface elevation and compensation would result. The model is intended to visualise this.

Mr. A. V. Hill: Thermopiles for investigating the thermal or the thermo-elastic properties of muscles. When a muscle is stimulated, heat is produced in four separate stages: (*a*) in the development, (*b*) in the maintenance and (*c*) in the disappearance of the mechanical response, and (*d*) in the processes of oxidative recovery. This heat-production is recorded by employing delicate insulated thermopiles and a sensitive galvanometer with photographic recording.

Prof. E. Mellanby: The effect of an accessory food factor (vitamine) on: (1) The production of rickets in puppies. Soft bones and other signs of rickets are produced in puppies (five to eight weeks old) when fed on diets unbalanced in that they contain too little of an accessory food factor (vitamine)—probably fat-soluble A. (2) The development of the teeth in puppies. Diets deficient in a vitamine, possibly fat-soluble A, produce teeth defectively calcified and more or less irregularly placed in soft jaws.

Mr. Julian Huxley and Mr. Lancelot T. Hogben: The relation of the thyroid to metamorphosis. The exhibits illustrated (1) acceleration of frog's metamorphosis by thyroid-feeding; (2) metamorphic changes in the axolotl induced by iodine; and (3) metamorphosis of Amblystoma by thyroid-feeding with a control.

Prof. R. Newstead: Samples of mite-infested flour. Flour which is heavily invested with mites (chiefly *Aleurobius farinae*) is certainly ruined. It has a most unpleasant odour, and in the early stages becomes discoloured owing to the quantities of excrement with which it is charged. Prevention from attack may be secured by storing flour with a low moisture content, *i.e.* below 11 per cent. in the temperate zone and from 6–7 per cent. in the tropics.

Prof. G. H. F. Nuttall and Dr. D. Keilin: Hermaphroditism in *Pediculus humanus*. The microscopic specimens illustrated hermaphrodites of intersexual type and included a complete series of forms from those of male type to those of female type, the co-existing characters of both sexes being present to a varying degree. The intersexual forms which occur among Pediculi in Nature are derived from the crossing of the races of *P. humanus*, *i.e. capitis* and *corporis*. Some of these crosses yield up to 20 per cent. of hermaphrodites.

Mr. J. E. Barnard: Photomicrographs obtained by means of ultra-violet light. It is well known that resolving power in the microscope is dependent on the N.A. of the objective and the wave-length of the light used. Decrease of wave-length results in proportionate increase of resolution, and this method opens up a promising field of investigation. There is the further advantage that biological preparations, particularly bacteria and other micro-organisms, are sufficiently opaque to ultra-violet light of suitable wave-length to render staining unnecessary. The result is that they can be photographed in the living state.

Dr. J. C. Mottram and Dr. E. A. Cockayne: Demonstration of fluorescence in Lepidoptera by ultra-violet radiation. The beam of ultra-violet rays is produced by means of a quartz mercury vapour lamp in a box with a window of the glass invented by Prof. Wood. This is transparent to radiation of wave-lengths lying between 3900 and 3100 A.V., but opaque to light. Only a small proportion of the Lepidoptera examined have proved to be fluorescent, and all of these are whitish or yellow in colour.

The Botany Department, Imperial College of Science and Technology: Recording porometer. This instrument records the rate at which air, under slightly reduced pressure, is drawn through the stomata (pores) into a glass cup fixed on the under-surface of the leaf. It thus gives a measure of the size of these pores. Every time a bubble of the air so drawn in escapes from the lower tube it momentarily makes contact between the mercury and a platinum wire; the current passing then moves the recording pen on the surface of the revolving drum.

The Cambridge and Paul Instrument Co., Ltd.: A new microtome. This instrument is designed on similar lines to the well-known Cambridge "rocking" microtome, but the object is in a much more convenient position for observation and orientation, and the microtome cuts plane sections in either paraffin or celloidin, and the design is suitable for freezing objects by ethyl chloride spray.

The Royal Geographical Society: Method of mounting panoramic views of wide angle. A photographic panorama of wide angle, made up from a number of separate pictures, gives a false impression

of the country if shown flat. The pictures should be enlarged to an equivalent focal length greater than the distance of distinct vision, and mounted in a polygon circumscribing a circle of radius equal to the focal length.

The Meteorological Office: New instruments and diagrams: (1) Land aneroid and sea aneroid. (2) Barometer with micrometric adjustment. (3) Two similar synchronous charts and the weather of the following fifteen days. (4) Normal weather on the Cairo to Cape route. (5) Charts of the average distribution of rainfall, cloudiness, and temperature over the northern and southern hemispheres in January and July. (6) Map of the annual rainfall in the English Lake District. (7) Records of the magnetic disturbance of March 23–24, 1920, and photographs of aurora for height-measurements. (8) Frequency of thunderstorms on the route between England and Australia and at selected stations in Africa and South America. (9) The flow of air over Kew Observatory, Richmond, during the last three years.

Air Ministry Laboratory: Apparatus for air navigation. (1) Four alternative methods for the quick solution of spherical triangles necessary for the obtaining of position lines from astronomical observations taken from aircraft: (*a*) The d'Ocagne nomogram. (*b*) A slide-rule based thereon. (*c*) The Veater diagram. (*d*) The Bygrave slide-rule. (2) Wimperis wind-gauge bearing plate, to enable the velocity and direction of the wind to be measured whilst in flight, (i) by flying on two courses and noting the drift angles, and (ii) by flying on one course and using a chronometer. (3) Capt. Weir's (Littrow projection) diagram applied to the purpose of obtaining position lines from W/T bearings.

The Admiralty Compass Department: (1) Two standard types of aircraft compasses. (2) Examples of aperiodic compasses for use in ships and aircraft. The aperiodic system adopted in these compasses is a result of the investigations of Mr. G. T. Bennett and the late Lt.-Comdr. C. Campbell.

Mr. E. A. Reeves: Apparatus for showing the existence of a true north and south directive force in the electricity of the atmosphere. This apparatus consists of a large glass bottle with an india-rubber stopper, from which is suspended by a fibre of unspun silk a gold-leaf paper indicator. The inner side of the stopper is covered with paraffin wax, and the bottle is coated inside and out with shellac varnish. The whole is mounted on a tripod stand. On a calm, clear day, when the apparatus is set up in a high open space and screened from the direct rays of the sun, it is found that after the paper is electrified by touching it with vulcanite rubbed on dry cloth, and left for some time, it will oscillate about evenly on either side of the true north and south line, or come to rest approximately in that direction.

Mr. C. V. Boys: (1) Noon reflector. The noon reflector is a very simple form of transit instrument intended to be set on a window-sill facing south and producing a pinhole-reflected image of the sun on the ceiling or opposite wall, from which the time may be obtained with an accuracy of about one second. (2) Azimuth declination time-chart. The azimuth declination time-chart is a graphic representation of the hour angle of the sun for all declinations at a particular latitude and azimuth from which the hour angle may be read with an accuracy of one-tenth of a second of time. This is for use with the noon reflector when set at some azimuth other than south.

The National Physical Laboratory: Oriented lustre of etched crystalline surfaces. The etched crystalline surface of metal is covered with a number of minute plane facets the orientation of which is uniform throughout each individual crystal, but varies from one crystal to the next. A beam of oblique light falling on such a surface is selectively reflected by these facets in such a way that the area of certain crystals appears uniformly and brightly illuminated, while other crystals remain dark. By illuminating such a surface by means of three separate beams of coloured light falling upon the crystals at various angles of incidence a striking effect is produced. Each crystal reflects into the eye of the observer a portion of one of the beams falling upon it at a suitable angle, and the various crystals consequently appear of different colours (Dr. W. Rosenhain and Mr. J. H. Haughton).

Messrs. Adam Hilger, Ltd.: Vacuum grating spectrograph for the extreme ultra-violet. A concave grating spectrograph, specially designed for the investigation of the Schumann and Lyman regions of the spectrum. No refractive substance (*e.g.* quartz or fluorite) is introduced, but the whole spectrum is obtained with one setting of the grating by the use of two slits. These are disposed in the end plate of the instrument, just above the plate-holder, which is cylindrical in form and provided with a plate for sealing purposes.

The Osmosis Co., Ltd.: Clays treated by electro-osmosis: Photomicrographs and specimens of articles made with osmosed clay. The phenomena of electrical osmosis, whereby matter in a very finely divided state is capable of being influenced by an electrical potential, have an important practical use in the purification of clays. Low-grade and discoloured china clays become usable as paper clays and pottery clays, and all china clays are improved in colour as a result of treatment.

Messrs. J. Crosfield and Sons, Ltd.: Synthetic products for perfumery. Synthetic perfumes of British manufacture were shown, most of which were formerly produced entirely in foreign countries. The manufacture was undertaken owing to the difficulty, in some cases impossibility, of obtaining such products during the war.

Mr. A. Mallock: Apparatus used in the determination of the variation of rigidity with temperature. The specimen to be tested forms part of a torsion balance, in which the restitutive couple is supplied by the torsion of a long thin wire, together with that of the specimen, the latter being in the form of a short wire or narrow strip about 2 in. long. The specimen and lower part of the balance can be immersed in a tube of fluid kept at any desired temperature. The periods of oscillation are automatically recorded for various temperatures, and the ratio of these periods furnishes the necessary data for determining the ratio of the rigidities. In making an experiment the oscillations are maintained continuously, the specimen being immersed successively in water at 100°, at room-temperature, in carbonic acid, in alcohol, and in liquid air.

Mr. C. R. Gibson for Mr. Joseph Goold: Experiments in rotational dynamics. The exhibit illustrated is a new development of Mr. Goold's earlier experiments in vibrating bars, the most remarkable of these being the vortex phenomenon demonstrated about a quarter of a century ago. The new experiments showed a rotational effect which is independent of the vortex phenomenon. A light clamp is fitted across the steel bar carrying an upright needle or rod, upon the free end of which is supported a light metal vane or "spinner." On setting the plate in vibration the spinner rotates with considerable energy. This rotation results from the interplay of two systems of vibration acting at right angles to each other. The following explanation is suggested by Mr. Gibson, who gave the demonstration: In one of the systems the bar vibrates between nodal lines which cross the width of the bar; this is termed a *normal* system.

In the other system of vibration the bar has a nodal line running along the longitudinal centre of the bar, while cross-nodes are also present; this class of vibration is termed a *dual* system. In the latter we may picture the sections of the bar on opposite sides of the central line to be out of phase with each other, so that one section is going upwards at the moment the other section is going downwards. This will give a slight rocking motion to the clamp, causing the free end of the needle to move to and fro in direction across the bar. Similarly, the bar is vibrating between the cross-nodes, so we may picture the sections divided by these to be upwards on one side of the cross-node and downwards on the other, thus giving a rocking motion to the needle in a direction lengthwise with the bar. These two motions (dual) combine to give the free end of the needle an elliptical motion; hence the rotation of the spinner.

The Hon. Sir Charles Parsons: Water-hammer cone demonstrating the destructive effect of collapsing vortex cavities. The apparatus consists of a hollow cone. At the small end is fitted a die-cap through which passes a hole of the same diameter as the small end of the cone. Between this cap and the cone thin metal plates are inserted. The cone is placed in water in the tank, allowed to fill with water, and then thrust quickly downwards, its mouth striking on to a rubber block at the bottom. The sudden arrest by the rubber block gives a high rate of relative acceleration of the water in the cone, producing momentarily a cavity at the apex, which, however, immediately closes again with a perceptible metallic hammering sound, and with sufficient pressure, due to the concentrated energy of the closing cavity at the apex, to puncture metal plates above 0·03 in. in thickness, indicating a pressure of 140 tons per square inch.

Mr. Edwin Edser: The concentration of minerals and coal by froth flotation. Many valuable minerals, particularly metallic sulphides, can be concentrated from low-grade ores by crushing these to a fine powder, mixing them with water, adding a small quantity of a suitable reagent, and agitating the mixture so that air is entrained in the form of fine bubbles. On allowing the mixture to come to rest, the bubbles carrying the mineral particles rise to the surface, and find a mineralised froth which can be removed. The barren rock (gangue) is not floated. Demonstrations were given of (1) the recovery of galena (lead sulphide) and blende (zinc sulphide) as separate products from Broken Hill ore; (2) the recovery of coal from waste dumps.

Sir Robert Robertson: Instrument for determining the pressure developed by detonators by Hopkinson's principle. This instrument, which was designed by Mr. H. Quinney at the Research Department, Woolwich, illustrated the quantitative measurement of the pressure of the blow delivered by a detonator according to the principle enunciated by Hopkinson. This principle depends on the separation of momentum into pressure and time. When the blow is applied to one end of a steel bar, a short length of the bar, attached by means of a faced joint to the other end, is thrown off as a result of the application of the pressure of the blow. The momentum of this short length (the "timepiece") is measured by catching it up in a ballistic pendulum. As the rate of transmission of the impulse in steel is known, the time taken for the pressure-wave to pass twice the length of the "timepiece" is also known, and so the pressure can be deduced.

Prof. F. W. Burstall: Optic indicator for internal-combustion engines. An instrument for obtaining the power and the pressure in internal-combustion engines. The objects aimed at are to obtain accurate readings of the pressures up to 600 lb. per square inch and speeds up to 2500 revolutions per minute.

University and Educational Intelligence.

CAMBRIDGE.—Mr. E. A. Milne, fellow of Trinity College, has been appointed assistant-director of the Solar Physics Observatory.

The new professorship of physical chemistry is declared vacant.

It is proposed to make it possible for students to take the first M.B. examination before coming into residence on account of the greater facilities now provided in schools for the teaching of chemistry, physics, and biology.

The discussion on the syndicate's report on the relation of women to the University is fixed for October 14.

The Local Lectures Summer Meeting will be held from July 29 to August 18. The main subject of study will be the history, literature, and art of Spain, but courses in physical science (historical and biographical) and in elementary astronomy are being arranged in co-operation with the Association of Science Teachers. Further information can be obtained from the Rev. Dr. Cranage, Syndicate Buildings, Cambridge.

LIVERPOOL.—Dr. Charles Walker has been appointed associate-professor in cytology and lecturer in histology.

Mr. J. Wemyss Anderson, dean of the faculty of engineering, and associate-professor of engineering in the University, has been appointed to the recently established John William Hughes chair of engineering-refrigeration.

Messrs. Alfred Holt and Co., Ltd., of Liverpool, have contributed 15,000*l.* to the University Appeal Fund. The Association of West African Merchants and the African Section of the Chamber of Commerce, Liverpool, have decided to raise 12,000*l.* by voluntary contributions from their members to provide a chair of Colonial commerce, administration, and history at the University and to increase the endowments of the School of Tropical Medicine.

LONDON.—The following courses of advanced lectures will begin shortly:—Three lectures on "The Early Civilisation of Malta," by Prof. Th. Zammit (of the University of Malta), at University College, at 5.30 p.m., on May 20, 27, and 28; four public lectures on "High-frequency Alternators for Radio-Telegraphy," at the Institution of Civil Engineers, S.W.1, by M. Marius Latour (of Paris), at 5.30 p.m., on May 26, 27, 28, and 31; and four lectures (in French) on "Divers Modes de Dynamisme des Eruptions Volcaniques et les Phénomènes de Latéritisation," at the Imperial College (Royal School of Mines), by Prof. A. Lacroix, at 5 p.m., on June 14, 15, 16, and 17. Admission to the courses is free, without ticket.

ANNOUNCEMENT is made of the impending retirement of Mr. T. P. Gill, who has been Secretary of the Department of Agriculture and Technical Instruction for Ireland since it was established.

THE Regional Association, in co-operation with the Civic Education League, proposes to hold a meeting at Glastonbury from August 21 to September 11. The purpose of the meeting will be (1) to make a regional survey, rural and civic, of Glastonbury and its surroundings, and (2) to proceed, from the material so obtained, to a critical study of social life and institutions. Particulars may be obtained from Mrs. Fraser-Davis, hon. secretary of the Regional Association, 1A Lancaster Place, Belsize Place, N.W.3, or 65 Belgrave Road, S.W.1.

THE Sorby research fellowship has been awarded to Dr. F. C. Thompson, of the department of applied sciences of the University of Sheffield, for research into the constitution of the alloy steels. The fellowship, which is tenable for five years, is awarded by a committee appointed by the council of the Royal Society and the University of Sheffield from a fund bequeathed by the late Dr. H. C. Sorby. Dr. Thompson holds the degrees of Doctor of Metallurgy (Sheffield) and Bachelor of Science (London). He was a Carnegie research scholar of the Iron and Steel Institute, is a member of many bodies concerned with physical and metallurgical matters, and has published a number of papers on metallography and allied subjects.

THE Dr. Jessie Macgregor prize for medical science, of the Royal College of Physicians, Edinburgh, is to be awarded in July to the applicant who presents the best record of original work in the science of medicine, published or unpublished, but must not have been published earlier than three years prior to the date of award of the prize. The prize, which is of the value of 75*l.*, is open to women medical graduates of the University of Edinburgh, or to those who have taken the triple qualification and before being qualified studied medicine for at least a year in Edinburgh. Applications for the prize, with a record of the work of the competitor, must be sent to reach the Convener of the Trustees, Royal College of Physicians, Edinburgh, by, at latest, June 1.

THE Bureau of Education in India has issued a pamphlet by Mr. R. K. Sorabji entitled "Facilities for Indian Students in America and Japan." Mr. Sorabji warns students that it is unwise for anyone to visit the United States on an allowance of 50 or 60 rupees per mensem, even though the student may make some money in the vacations; he requires from 150*l.* to 200*l.* a year, of which he may earn 50*l.* The facilities for technical education and the cheapness of it may attract the student to Japan, but the candidates for admission to the colleges exceed the accommodation, and when a system of competitive examination is introduced, the youth trained in a Japanese school possesses greater advantages than the Indian. As is the case in the United States, the student will require an allowance of from 100*l.* to 150*l.* per annum, and as the teaching is given in Japanese he must acquire that language before he can derive any advantages from Japanese institutions.

Societies and Academies.

LONDON.

Royal Society, May 6.—Sir J. J. Thomson, president, in the chair.—R. H. **Fowler**, E. C. **Gallop**, C. N. H. **Lock**, and H. W. **Richmond**: The aerodynamics of a spinning shell. This paper deals with the motion through a gas or a body with an axis of symmetry and a spin about that axis. The range of velocities includes the velocity of sound in the gas. It has special reference to the motion of an ordinary shell through air under gravity. The problem is approached from the aerodynamical viewpoint. The force system imposed by the gas is analysed into its most important constituents by help of the theory of dimensions and by detailed wind-channel experiments. The general equations of motion are obtained in a vector notation, and reduced to tractable approximate forms in certain important special cases; in particular, when the axis of symmetry and the direction of motion of the centre of gravity nearly coincide. An approximate formal solution of these last equations is obtained, and the errors in the equations themselves and their solutions are shown to be negligible. The solutions obtained are submitted to the test of experiment, and the magnitude of the more important members of the force system determined numerically as functions of the velocity of the shell up to twice the velocity of sound. At the same time the main assumptions made in the analysis are verified. The experimental method used is to fire the shell through a series of cards. The shape of the holes left in the cards determines accurately the angular motion of the axis of the shell. From this the values of the chief components of the force system are deduced. One of the principal results is to determine accurately the spin required to render the shell stable at any velocity. The behaviour of the force components as functions of the velocity appears to be of scientific interest, and of obvious importance in technical ballistics.—Prof. W. E. **Dalby**: Researches on the elastic properties and the plastic extension of metals. This paper relates to a new type of load-extension diagram recorded automatically by an adaptation of an instrument already described to the society. The extension of the test piece is multiplied 150 times by the instrument. With this magnification, about $\frac{3}{100}$ extension is shown on the negative, and the elastic line appears at a slope of about 60°. The shape of the elastic line can therefore be studied and the process of extension can be watched, so that stretching can be stopped at an assigned value and the load removed and then re-applied. The removal and re-application of the load produce a loop on the diagram, and several such loops can be described on each negative. Looped diagrams taken from metals commonly used were shown. Comparisons of these looped diagrams show that each metal is characterised by its elastic line and loops. A succession of plates was taken from a test piece of high carbon steel stretched almost to breaking. These plates set end to end give a procession of loops, and show that the loop area tends to a maximum. The questions of time-interval between the taking of loops and heat treatment between the taking of loops are examined in relation to loop area. It is shown that in the high carbon steel and alloy steel lapse of time has little or no effect in restoring elasticity, nor is the elasticity restored by boiling in water. New data relating to the strength of materials are given by these diagrams, viz.: (1) The area of the loop. (2) The rate of increase of the area of the loop. (3) The maximum area.—C. T. R. **Wilson**: Investigations on lightning discharges and on the electric field of thunderstorms. The investigations were carried out at the Solar Physics Observatory, Cambridge, by methods already described (Proceedings, 1916). Apparatus has been added to secure a photographic record of the readings of the capillary electrometer used in the measurements. Changes in the electric field which occupy less than a tenth of a second are recorded. The sudden changes produced in the potential gradient by the passage of lightning discharges recorded in 1017 were positive in 432 cases and negative in 279. The mean value of the electric moment 2QH (Q being the quantity discharged and H the vertical height through which this charge is displaced) of a lightning discharge is about 3×10^{16} e.s.u. × cm. or 100 coulomb-kilometres. The mean quantity discharged is of the order of 20 coulombs. The magnitude of the potentials attained in thunderclouds is of the order of 10^9 volts. The rate of vertical separation of charges in a thundercloud may amount to some coulombs per second, *i.e.* the vertical current through the cloud is of the order of some amperes. A thundercloud or showercloud may be regarded as an electric generator, capable of maintaining between

its poles an electromotive force of the order of 10^9 volts. It tends to maintain an electric current from the earth to the conducting layers of the upper atmosphere or in the reverse direction, according as its polarity is + or −. The difference which must exist in the conductivity of the air above showerclouds of + and of − polarity respectively, owing to the large difference between the mobilities of the negative and positive ions dragged out of the conducting layer by the field of the cloud, furnishes a possible explanation of the normal positive potential gradient at a distance from showerclouds. It is also shown that it will account for the prevailing negative sign of the potential gradients associated with showerclouds and for the preponderance of positively charged rain and positive lightning discharges, *i.e.* discharges which produce a positive change of potential gradient.—L. F. **Richardson**: The supply of energy to atmospheric eddies. Osborne Reynolds investigated the energy of eddies as a balance between income and expenditure. The income was the activity of the eddy stresses upon the corresponding rates of mean strain; the expenditure was by way of molecular viscosity. His theory refers to an incompressible liquid, but it is shown in the present paper that the same applies to an elastic fluid. In a gravitating atmosphere there is an additional channel for gain or loss, because the eddies act as thermo-dynamic engines, either producing or decreasing inequalities of temperature. They are, however, imperfect engines. It is shown that the activity contributed by the eddies by this process is

$$\frac{g}{\gamma p} c \frac{\delta \sigma}{\delta h} \text{ per volume,}$$

where g is the acceleration of gravity, γp the thermal capacity per mass, c the eddy-conductivity, σ the entropy per mass, and h the height. In the actual atmosphere this activity is ordinarily an expenditure by the eddies. By balancing it against their income a criterion of turbulence is obtained. Some observations of the quiescence of wind on a clear evening tend to confirm the theory.

Geological Society, May 5.—Mr. G. W. Lamplugh, vice-president, in the chair.—S. H. **Warren**: A natural "eolith" factory beneath the Thanet Sand. The paper describes a section in the Bullhead Bed at Grays, where the conditions have been favourable for the chipping of the flints by subsoil pressure. There is evidence of extensive solution of the chalk beneath the Tertiary deposits, and the differential movements thus brought about have occasioned much slickensiding, and remarkable effects in the chipping of the flints. In the author's opinion the section affords the most complete and conclusive evidence hitherto obtained in support of the theory of the origin of the supposed eolithic implements by purely natural agencies. There are not only the simpler Kentish types, such as notches, bowscrapers, and the like, but also the larger and more advanced forms of rostro-carinates, which are characteristic of the sub-Crag detritus-bed. Careful digging enables the pressure-points of one stone against another and the resultant chipping effects to be studied in detail; and in many instances the flakes removed can be recovered and replaced. A few examples are more than merely eolithic in character. If such exceptional examples were removed from their associates, and also from the evidences of the geological forces to which they have been exposed, no investigator could be blamed for accepting them without question as of Mousterian workmanship. Individual specimens may often deceive: in order to distinguish a geological deposit of chipped flints from the débris of a prehistoric chipping-floor, it is necessary to base one's judgment upon fairly representative groups, and also to take into consideration the circumstances in which they have been discovered.

CAMBRIDGE.

Philosophical Society, March 8.—Mr. C. T. R. Wilson, president, in the chair.—H. H. **Brindley**: Further notes on the food-plants of the common earwig (*Forficula auricularia*). The observations on the food-plants of the common earwig made on a small scale in 1917 (Proceedings, xix., part 4, 1918, p. 171) were continued in the summers of 1918 and 1919 on earwigs kept in captivity in connection with a statistical inquiry on variation. Altogether about ninety species of common plants, chiefly garden varieties, were used. Among the most favourite foods were the *leaves* of Jerusalem artichoke, beetroot, pink begonia, garden cabbage, centaurea, delphinium, leek, *Malvus sylvestris*, vegetable marrow, mignonette, white pyrethrum, scarlet runner, seakale, and tomato; and the *petals* of blue Anchusa, China aster, pink begonia, blackberry, different varieties of campanula, white clematis, dandelion, Gesneria, white marguerite, mint, corn parsley, white phlox, yellow Œnothera, rose, tomato, red valerian, blue verbena, and varieties of vetches. Among *fruits* green fig, honeysuckle, and plum were well attacked, while apple was neglected until the skin was removed, and then eaten comparatively little. Potato and artichoke *tubers*, save dormant buds on the latter, escaped attack in their skins, but when sliced they were thoroughly devoured. The hairy undersides of the leaves of raspberry and blue verbena and the curled edges of Scotch kale leaves are very attractive to earwigs for hiding in in the day-time, and onion inflorescences, poppy capsules, buds of hollyhock, petals of garden chrysanthemums and snapdragon are also popular refuges. The last two and Scotch kale leaves were also nibbled moderately, but the conclusion formed in 1917 that the actual damage done to chrysanthemums by earwigs is usually exaggerated was confirmed by the later observations.—Miss Maud D. **Haviland**: Preliminary note on antennal variation in an Aphid (*Myzus ribis*, Linn.). The red currant Aphis (*Myzus ribis*, Linn.) shows variation of the antennæ in the winged females, according to whether they are fed upon healthy leaves or upon leaves blistered by the sucking of previous generations. In forms from the blisters the large sense-organs, situated upon antennal joints v. and vi., are placed nearer the articulation of these joints than in forms from healthy leaves. Experiments on transference of blister-fed descendants of a single ancestor to healthy leaves showed but slight change in the first two or three generations. Subsequent generations, however, showed marked increase above the ancestral mean, though identical generations, fed only upon blistered leaves, had a mean similar to that of their ancestors.—Dr. **Fenton** and A. J. **Berry**: Studies on cellulose acetate. The authors gave a short account of certain observations of general chemical interest obtained in the course of an investigation on aeroplane dopes.—G. T. **Bennett**: The rotation of a non-spinning gyrostat, and its effect in the aeroplane compass. "A symmetrical wheel free to rotate about its axle is moved from rest in any position by means of the axle, and is finally restored to a position in which the axle again points in the same direction as formerly. Show that the wheel, again at rest, will have rotated through a plane angle equal to the solid angle of the cone described by the varying directions of the axle" (College Examination Problem Paper, 1898). The kinematics of the angular motion of the wheel is

represented by the rolling of the plane of the wheel on a fixed cone of arbitrary form. The surface-angle of the cone differs from four right angles by the final angular displacement of the wheel. The same angle of rotation is also measured by the solid angle of the reciprocal cone described by the axis of the wheel. This movement is not yet among those that are familiarly recognised, though it has important practical applications. Bodies suspended from a point on an axis of symmetry behave in the same way and for the same reason when swung about by movements of the point of support. Aeroplane compass-cards in particular (found to keep practically parallel to the banked floor of the aeroplane under the action of gravity and lateral acceleration during a turn) would, from inertia alone, and apart from all other sources of control or disturbance, turn with the machine through an angle geometrically calculable from the movement of the aeroplane.—C. G. **Darwin**: Lagrangian methods for high-speed motion. The general form of the kinetic potential is found for any number of electrically charged particles moving in any field of electric and magnetic force, allowing for the variability of mass with velocity and for the "retardation" of the forces of interaction of the particles. The result is applied to the "problem of two bodies." The relative orbit is a distorted ellipse with moving apse, and there is no simply definable centre of mass for the system. The finiteness of mass of the hydrogen nucleus is found to have absolutely no effect on the separation of the doublets in the hydrogen spectrum.—H. P. **Waran**: The effect of a magnetic field on the intensity of spectral lines. The paper discusses the changes observed in the general spectrum and in the intensity of the lines when the source is placed in a magnetic field. In the case of mercury the field brings out a few lines previously faint or absent, and the abnormal behaviour of the line 6152, which is very prominently brought out, is discussed. In the spectrum of the monatomic gases helium and neon mixed with the diatomic gases oxygen and hydrogen, only the monatomic lines are enhanced very much in brightness, and on this view the fact of the lines getting enhanced in the magnetic field is attributed to atomic radiation. The differences in the degrees of enhancement are said to depend on the series to which the lines belong, and the enhanced lines in the sun-spot spectrum are attributed to this effect of the magnetic field known to exist there.—C. V. H. **Rao** and Prof. **Baker**: Generation of sets of four tetrahedra mutually inscribed and circumscribed. This paper shows how the figure is obtainable by a generalised process of inversion from a single tetrahedron, and applies the same method to a certain configuration in four dimensions.—S. **Pollard**: The term-by-term integration of an infinite series over an infinite range, and the inversion of the order of integration in repeated infinite integrals.—S. R. U. **Savoor**: Rotating liquid cylinders. This paper applies the method followed by Liapounoff, for the case of ellipsoids, to the consideration of the stability of the so-called pear-shaped cylinder.

DUBLIN.

Royal Dublin Society, April 27.—Dr. F. E. Hackett in the chair.—Prof. W. E. **Adeney** and H. G. **Becker**: The rate of solution of atmospheric nitrogen and oxygen by water (Part iii.). This paper deals with experiments made with bodies of quiescent water, the results of which show that under ordinary conditions mixing of the water takes place to such an extent that a modification of the formula previously deduced can be used to interpret the process. The effect of the humidity of the air above the surface of the water is also dealt with and its influence on the rate of solution indicated.—Dr. J. **Reilly** and W. J. **Hickinbottom**: (1) The influence of electrolytic dissociation on the distillation in steam of the volatile fatty acids. Changes in the distillation constants of the fatty acids are fully accounted for by introducing a correction for electrolytic dissociation. Observations are given on the influence of salts. (2) Some applications of the method of distillation in steam. A survey of the method, discussing its theoretical and industrial applications, especially in the analysis of butter and other edible fats and oils.

PARIS.

Academy of Sciences, April 26.—M. Henri Deslandres in the chair.—A. **Haller** and R. **Cornubert**: The constitution of the methylethyl*cyclo*hexanone prepared by the ethylation of α-methyl*cyclo*hexanone. This compound is shown to possess an unsymmetrical structure, both the alkyl groups being attached to the same carbon atom in the ring.—H. **Douvillé**: The origin of the Orbitoids.—A. **Blondel**: Theorems on the transmission of energy by alternating current analogous with those of Siemens on transmission by continuous current. Criticism of these theorems.—E. **Maillet**: Some properties of transcendental numbers.—C. **Camichel**: The permanent state in water reservoirs.—A. **Perot**: The variation with pressure of the wavelength of the lines of the cyanogen band.—F. **Bourion**: A method of physico-chemical analysis of commercial chlorobenzenes. By fractional distillation the specimen is divided into portions each containing only two constituents; measurements of density serve to determine the composition of each fraction. The accuracy obtained is illustrated by examples.—A. **Kling** and D. **Florentin**: The differentiation of masked and apparent sulphuric ions in complex salts. The use of benzidine as a reagent, suggested in a recent paper by P. Job and G. Urbain, was anticipated by the authors in 1914 in a study of solutions of the green chromium sulphate.—V. **Auger**: The salts of nitrosophenylhydroxylamine (cupferron): uranous salts. Uranic salts are not precipitated by cupferron, and vanadium can be quantitatively precipitated by cupferron in the presence of uranium, as was shown by Turner in 1916. If, however, by zinc reduction the uranic salts are converted into uranous compounds, the uranium can be precipitated also by cupferron, and under these conditions vanadium and uranium can be successively determined by means of the cupferron.—G. **Deniges**: Iodic acid as a microchemical reagent for calcium, strontium, and barium. A 10 per cent. solution of iodic acid forms a good reagent for the microchemical identification of calcium, strontium, and barium salts, soluble or insoluble. One milligram of material is sufficient for the purpose.—Ch. **Mauguin** and L. J. **Simon**: The action of chlorine, hypochlorous acid, and cyanogen on cyanamide and its derivatives.—P. **Bertrand**: Value of the primary centripetal metaxylem of old or primitive plants.—M. **Guilliermond**: The evolution of the chondriome during the formation of the pollen-grains of *Lilium candidum*.—H. **Devaux** and H. **Bouygues**: The usefulness of sodium fluoride employed as an antiseptic for the preservation of railway-sleepers. The scarcity of creosote has led railway companies to try other antiseptics for the preservation of wooden sleepers, and, among others, sodium fluoride has been extensively used. While there is no doubt as to the efficiency of sodium fluoride as an antiseptic, on account of the ease with which it is extracted by water, it is useless for the preservation of wood exposed to rain, and especially for the case of railway-sleepers.—A. **Desgrez**

and M. **Polonowski**: Determination of the total non-amino organic acids of the urine.—H. **Colin**: The diastatic hydrolysis of inulin. An account of some unsuccessful attempts to isolate products of hydrolysis intermediate between inulin and the reducing sugars.—J. E. **Abelous** and J. **Aloy**: Digestive hydrolyses by mechanical ionisation of water. Violent agitation is sufficient to determine a partial hydrolysis of solutions of starch, lactose, neutral fats, and fibrin. The effects increase with rise of temperature.—J. **Chaine**: Considerations on the paramastoid apophysis of man.—A. **Krempf**: Observations on the development of *Pocillopora cespitosa* and *Seriatopora subulata*. Discovery of primitive stages revealing the scyphostrobiliary origin of the Anthozoa.—MM. **Weinberg** and **Nasta**: *Rôle* of the hæmolysins in microbial intoxication and the therapeutic properties of normal sera.—A. **Marie**, C. **Levaditi**, and G. **Banu**: Experimental transmission of the triponeme of general paralysis (*virus neurotrope*) by sexual contact.

Books Received.

The Idea of Progress: An Inquiry into its Origin and Growth. By Prof. J. B. Bury. Pp. xv+377. (London: Macmillan and Co., Ltd.) 14*s*. net.

Nauka Polska. Tom ii. Pp. ix+676. (Warszawa.) Cena M.P. 25.

Dumbartonshire. By Dr. F. Mort. Pp. viii+155. (Cambridge: At the University Press.) 4*s*. 6*d*. net.

Orkney and Shetland. By J. G. F. Moodie and H. and T. Mainland. Pp. xii+167. (Cambridge: At the University Press.) 4*s*. 6*d*. net.

Report on the Quantum Theory of Spectra. By Dr. L. Silberstein. Pp. iv+42. (London: Adam Hilger, Ltd.) 5*s*. net.

Problems of Population and Parenthood: Being the Second Report of and the Chief Evidence taken by the National Birth-Rate Commission, 1918–20. Pp. clxvi+423. (London: Chapman and Hall, Ltd.) 25*s*. net.

Diary of Societies.

THURSDAY, MAY 20.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—A. P. Graves: Welsh and Irish Folk Song.

ROYAL SOCIETY, at 4.30.—Prof. J. N. Collie: Some Notes on Krypton and Xenon.—Sih Ling Ting: Experiments on Electron Emission from Hot Bodies, with a Preface by Prof. O. W. Richardson.—Dr L. Silberstein: The Aspherical Nucleus Theory Applied to the Balmer Series of Hydrogen.—Dr. T. E. Stanton, Miss D. Marshall, and Mrs C. N. Bryant: The Conditions at the Boundary of a Fluid in Turbulent Motion.

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.—Brig.-Gen. Lord Montagu of Beaulieu: Roads and Transport in India.

ROYAL SOCIETY OF MEDICINE (Dermatology Section), at 5.—Annual General Meeting.

INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.—G. Rigg: Roasting and Lead-Smelting Practice at the Port Pirie (S.A.) Plant of the Broken Hill Associated Smelters Proprietary, Ltd.—Capt. H. Tatham: Tunnelling in the Sand Dunes of the Belgian Coast.

INSTITUTION OF ELECTRICAL ENGINEERS (at Institution of Civil Engineers), at 5.30.—(Annual General Meeting.)

NUMISMATIC SOCIETY, at 6.

OPTICAL SOCIETY, at 7.30.—B. K. Johnson: The No. 7 Dial Sight, Mk II.—Lt.-Col. Gifford: A Short High Power Telescope.

CHEMICAL SOCIETY (Ordinary Meeting; Informal Meeting), at 8.—D. J. and Mrs. Matthews: Exhibit demonstrating the Methods of Controlling Soil Organisms now being Investigated at the Rothamsted Experimental Station.—Dr. Marie Stopes: Exhibit Specimens and Microscopic Slides of Fusain, Durain, Clarain, and Vitrain, the Four Main Constituents of Banded Bituminous Coal.—E. R. Thomas: Experiments Illustrating the Influence of Temperature, Concentration, Solvent, Constitution, and Catalyst on the Rate of Chemical Change.

SOCIETY OF ANTIQUARIES, at 8.30.

FRIDAY, MAY 21.

ROYAL SOCIETY OF MEDICINE (Otology Section), at 5.—Annual General Meeting.

WIRELESS SOCIETY OF LONDON (at Institution of Civil Engineers), at 6.—P. Coursey: Some Methods of Eliminating Atmospherics in Wireless Reception.

ROYAL SOCIETY OF MEDICINE (Electro-Therapeutics Section), at 8.30.—Annual General Meeting.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. J. A. Fleming: The Thermionic Valve in Wireless Telegraphy and Telephony.

SATURDAY, MAY 22.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Frederic Harrison: The Re-action and the Critics of the Positivist School of Thought.

TUESDAY, MAY 25.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Major C. E. Inglis: The Evolution of Large Bridge Construction.

WEDNESDAY, MAY 26.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 8.—Sir Richard T. Glazebrook: Some Points of Importance in the Work of the Advisory Committee for Aeronautics.

THURSDAY, MAY 27.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—William Archer: Dreams, with Special Reference to Psycho-Analysis.

LINNEAN SOCIETY (Anniversary Meeting), at 3.

ROYAL SOCIETY, at 4.30.

CONCRETE INSTITUTE (Annual General Meeting, followed by an Ordinary Meeting), at 7.30.

FRIDAY, MAY 28.

ROYAL SOCIETY OF ARTS (Indian and Colonial Sections, Joint Meeting), at 4.30.—Prof. W. A. Bone: Lignite.

ROYAL SOCIETY OF MEDICINE (Study of Disease in Children), at 4.30.—(Annual General Meeting.)

PHYSICAL SOCIETY OF LONDON, at 5.—Sir W. H. Bragg and Others: Discussion on X ray Spectra.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. W. L. Bragg: Crystal Structure.

SATURDAY, MAY 29.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. J. H. Jeans: The Theory of Relativity (Tyndall Lectures).

CONTENTS.

NOTICE.

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