NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

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

No. 2550, Vol. 102] THURSDAY, SEPTEMBER 12, 1918 [Price Sixpence.

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IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY,

LONDON, S.W. 7.

DEPARTMENT OF TECHNICAL OPTICS.

Professor and Director ...	F. J. CHESHIRE, C.B.E., A.R.C.S.
Professor of Optical Design	A. E. CONRADY, A.R.C.S.
Lecturer	L. C. MARTIN, D.I.C., A.R.C.S., B.Sc.

During Session 1918-19, and pending the establishment of full-time courses of study leading to one of the Diplomas awarded by the Governing Body, a series of courses of lectures will be given, with corresponding laboratory work, designed especially to meet the needs of part-time students engaged in the optical industry; but available also for students who wish to study Applied Optics with a view to entering the profession of optical designing and testing.

For the present, and pending the establishment of full-time courses of study, the case of each student wishing to enter the Department for full-time work will be specially considered by the Director of the Department, who will determine the course of study to be followed.

The Lecture Courses for the Autumn Term, 1918, are as follows:—

"GENERAL OPTICS."*

By Professor F. J. CHESHIRE.

Beginning on Friday, October 4, 1918, at 2.30 p.m.

"OPTICAL DESIGNING AND COMPUTING."*

By Professor A. E. CONRADY.

Beginning on Monday, October 7, 1918, at 2.30 p.m. (Lectures suitable for Beginners.)

"PRACTICAL OPTICAL COMPUTING."*

By Professor A. E. CONRADY.

Beginning on Tuesday, October 1, 1918, at 2.30 p.m. (Suitable for more advanced students.)

"WORKSHOP AND TESTING-ROOM METHODS."*

By Professor A. E. CONRADY.

Beginning on Thursday, October 3, 1918, at 2.30 p.m.

"THE CONSTRUCTION, THEORY, AND USE OF OPTICAL MEASURING INSTRUMENTS."*

By Mr. L. C. MARTIN.

Beginning on Wednesday, October 2, 1918, at 2.30 p.m.

"MICROSCOPES AND MICROSCOPIC VISION."

By Professor A. E. CONRADY.

Beginning on Thursday, October 3, 1918, at 5 p.m.

These lectures are intended specially for users of the microscope, and will be as far as possible non-mathematical.

* Each lecture will be followed by a Laboratory or Computing Class.

All inquiries in respect of the above should be addressed to—

THE REGISTRAR OF THE IMPERIAL COLLEGE,
Imperial Institute Road,
South Kensington, S.W. 7.

THE UNIVERSITY OF SHEFFIELD.

OPENING OF SESSION 1918-1919.

The Session OPENS as follows:—

DAY CLASSES.

FACULTY OF ENGINEERING	September 23
FACULTY OF METALLURGY	September 23
FACULTY OF ARTS	October 2
FACULTY OF PURE SCIENCE	October 2
FACULTY OF MEDICINE	October 2
FACULTY OF LAW	October 2

EVENING CLASSES.

FACULTY OF ENGINEERING	September 23
FACULTY OF METALLURGY	September 23
FACULTY OF ARTS	October 7
FACULTY OF PURE SCIENCE	October 7
FACULTY OF LAW	October 7

W. M. GIBBONS, Registrar.

UNIVERSITY OF LONDON, UNIVERSITY COLLEGE.

(UNIVERSITY CENTRE FOR MEDICAL SCIENCES.)
FACULTY OF MEDICAL SCIENCES.

Dean.—G. D. THANE, LL.D., Sc.D., F.R.S. (Professor of Anatomy).
Vice-Dean.—J. P. HILL, D.Sc., F.R.S. (Professor of Zoology and Comparative Anatomy).

The SESSION 1918-19 BEGINS on MONDAY, SEPTEMBER 30.

Courses of instruction are arranged for the First Medical and the Second Medical Examinations of the University, as well as for the corresponding examinations of the Examining Board of the Royal Colleges of Physicians and Surgeons and other Licensing Bodies.

Postgraduate and Research Work is provided for in all departments.

All courses in this Faculty are open to women students on the same terms as to men.

FEES.—For the First Medical Course, 26 guineas, and for the Second Medical Course, 58 guineas; both including subscription to the Union Society, which entitles to the use of the Gymnasium and of the Athletic Ground.

University College Hall, Ealing (Warden, Walter W. Seton, M.A., D.Lit.), provides residence for Men Students.

College Hall, Byng Place, Gordon Square, W.C. 1 (Principal, Miss Thyra B. Alleyne, M.Litt.), provides residence for Women Students.

For prospectus and other information apply to the undersigned.

WALTER W. SETON, M.A., D.Lit.,
Secretary.

University College, London
(Gower Street, W.C. 1).

UNIVERSITY OF LONDON.

KING'S COLLEGE, AND KING'S COLLEGE FOR WOMEN.

FACULTY OF SCIENCE.

In this Faculty a Course of Study in Science is provided suitable for general education or for the Examinations of the London and other Universities. Students are admitted either as Regular or Occasional Students. Several valuable Scholarships and Prizes are offered. The Laboratories of the College are open to post-Graduates and Research Students. The following are the Departments under the charge of the various Professors, assisted by the Junior Staff:—

Mathematics	Prof. S. A. F. WHITE, M.A., and Prof. J. W. NICHOLSON, M.A., D.Sc.
Physics	Prof. O. W. RICHARDSON, D.Sc., F.R.S.
Chemistry...	Prof. Sir H. JACKSON, K.B.E., F.R.S., and Prof. A. W. CROSSLEY, C.M.G., D.Sc., F.R.S.
Botany	Prof. W. B. BOTTOMLEY, Ph.D., F.L.S.
Zoology	Prof. ARTHUR DENDY, D.Sc., F.R.S.
Geology and Mineralogy	Dr. W. T. GORDON, F.R.S.E.
Physiology	Prof. W. D. HALLIBURTON, M.D., LL.D., F.R.S.
Psychology	Dr. W. BROWN, M.A., M.B., and Dr. WILDON CARR.

The next TERM begins WEDNESDAY, October 2, 1918.

For particulars as to this and other Faculties of the College—Engineering, Medicine, Arts, Laws, and Theology—apply to the SECRETARY, King's College, Strand, W.C. 2.

ENGINEERING AND TECHNICAL OPTICS.

NORTHAMPTON POLYTECHNIC INSTITUTE,

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

ENGINEERING DAY COLLEGE.

Full Day Courses in the Theory and Practice of Civil, Mechanical and Electrical Engineering will commence on Monday, September 30, 1918. The Courses in Civil and Mechanical Engineering include specialisation in Automobile and Aeronautical Engineering, and those in Electrical Engineering include specialisation in Radio-Telegraphy.

Entrance Examination on Tuesday and Wednesday, September 24 and 25, 1918. These courses include periods spent in commercial workshops, and extend over four years. They also prepare for the Degree of B.Sc. in Engineering at the University of London. Fees £15 or £11 per annum.

Three Entrance Scholarships of the value of £52 each will be offered for competition at the Entrance Examination in September, 1918.

TECHNICAL OPTICS.

Full and Part Time Courses in this important department of Applied Science will be given in specially equipped laboratories and lecture rooms. *An Aitchison Scholarship* (value £30) will be offered in this department at the Entrance Examination.

Full particulars as to fees, dates, &c., and all information respecting the work of the Institute, can be obtained at the Institute or on application to

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

For other Official Advertisements see page x and page ii of Supplement.

THURSDAY, SEPTEMBER 12, 1918.

INDUSTRIAL CHEMISTRY.

I.

(1) *The Manufacture of Intermediate Products for Dyes.* By Dr. J. C. Cain. Pp. xi+263. (London: Macmillan and Co., Ltd., 1918.) Price 10*s.* net.

(2) *The Alkali Industry.* By J. R. Partington. Pp. xvi+304. ("Industrial Chemistry.") (London: Baillière, Tindall, and Cox, 1918.) Price 7*s.* 6*d.* net.

(3) *Edible Oils and Fats.* By C. A. Mitchell. Pp. xii+159. ("Monographs on Industrial Chemistry.") (London: Longmans, Green, and Co., 1918.) Price 6*s.* 6*d.* net.

CHEMICAL industry in this country is slowly, but let us hope surely, coming into its own. Public interest has been directed to it, and its importance to the nation has been recognised, though there is still much leeway to make up in this respect. The industry also is finding itself from within; combination and association are taking the place of antagonism and aloofness, and before long the industry will speak with one voice to the public and to the Government on matters which concern it. One of the minor indications of progress is the increase both in the quantity and quality of our chemical publications, the enlarged Journal of the Society of Chemical Industry being a particularly valuable asset to the industry. The movement to produce text-books of industrial chemistry in English is of prime importance for the future of the industry; in the past we have been far too prone to resort to German works or their translations. Indeed, had it not been for the fortunate completion of Thorpe's "Dictionary of Chemistry" just before the war, English chemical workers ignorant of German would have been considerably handicapped.

An industrial text-book may be judged from several standards, depending on whether it aims at giving a complete account of modern practice in the particular industry or limits its scope to describing chemical theories and their applications to that industry. It may seek to be a work of reference to all engaged in the industry, or merely an introduction to beginners, or it may aim at stimulating progress by outlining the applicability of the most modern discoveries. The first type of book can be produced only by a writer who has had intimate experience in the industry and is free to put his information on record for the use of others. Normally, the majority of those possessing such knowledge are either pledged not to disclose it, or professionally engaged as consultants. The second type of book is more usual, and is naturally much more complete on the theoretical than on the practical side; it must be held to be successful if it encourages a greater knowledge of chemical science and scientific method and leads to progress in the industry.

(1) Dr. Cain is one of the few who are qualified to speak with authority on both the technical and chemical sides of the production of coal-tar colours, and not only is his book on the intermediate products certain to become the standard work on the subject, but also, what is more important, it should save an immense amount of time and money to those actually engaged in the industry. It has been pointed out at more than one shareholders' meeting lately that the intermediates are even more important than the dyes themselves, and that the provision of adequate plant for their manufacture is the first step in the establishment of a British dye industry. The intermediate products are so numerous, and so much depends on their cheap production, that it is quite irrational for each competing firm to manufacture its own requirements, and it is for this reason more than any other that it is desirable to establish a combine of the colour-making firms so as to manufacture intermediates in quantity, and therefore cheaply, at one or more specially equipped large works, and convert these to the finished dyestuffs at the existing smaller establishments.

Dr. Cain aims at providing in a convenient form detailed information as to the preparation of intermediates, the most trustworthy method of manufacture of each substance being recorded. Both the pure chemistry of the subject and chemical engineering details have been omitted. The chief chemical reactions employed—viz. nitration, nitrosation, halogenation, sulphonation, reduction, oxidation, fusion with alkali, hydrolysis, amidation, alkylation, acylation, condensation—are dealt with in the order enumerated.

This is not the place for any criticism in detail, which in any case must be a matter of personal opinion, and Dr. Cain's name is sufficient guarantee that no pains have been spared to render the work complete in every detail. Progress in this, as, indeed, in most branches of industry, has been gradual; perhaps at the moment the most marked trend is in the direction of the increased use of catalytic agents; there is also a great future for electrical energy, particularly in connection with oxidation and reduction. Oxidation in particular is to-day brought about by cumbersome and costly methods in comparison with what may be expected when it is possible to make use of atmospheric oxygen in conjunction with a catalyst.

(2) Mr. Partington's book, though entitled "The Alkali Industry," really deals with acids, alkalis, chlorine, and potassium salts, and practically half of it is devoted to nitric acid and ammonia, particularly the modern methods of their manufacture, which are being so much discussed at the present time. It forms one of a series of volumes, edited by Dr. Rideal, designed to show how chemical principles have been applied and have affected manufacture. The treatment is certainly novel, and it appears to the present re-

viewer to be successful in that it provides a book which is far more readable than the ordinary text-books on the subject. Naturally, the author cannot hope to be in practical touch with so wide a field, and in his efforts to secure the necessary condensation somewhat unequal treatment has resulted; indeed, the first half of the book is far too condensed. In consequence, there are numerous points of detail which might be criticised adversely, and to this extent it fails to give an accurate picture of the industry. But such criticism is of minor importance as compared with the potential power of the work to stimulate interest, and it should certainly be placed in the hands of every process manager and chemist and of all students who wish to enter chemical industry. They cannot fail to read it and feel that there is still progress to be made in their processes, and that the chemical theory even of such well-worn manufactures as acid and alkali making has made great developments since the application of physical chemistry was understood.

So much interest attaches to-day to nitric acid, the importance of which in time of war and, it is to be hoped also, in time of peace to the nation is at last being understood, that the author may be forgiven for expanding on this subject. Quite apart from the future exhaustion of the deposits of Chile nitrate, once so eloquently pictured by Sir William Crookes, the invention of the submarine has introduced new problems into the transport of this material in time of war. The problem of the fixation of atmospheric nitrogen has been solved in Germany, and its solution here is, of course, only a matter of time. The problem was one demanding huge expenditure and prolonged experiment, and not commercially attractive to business undertakings hampered by unintelligent taxation; it is essentially national in character, and must be undertaken with State assistance, as it is by no means certain that under peace conditions the synthetic product can compete with the natural.

On account of the difficulties attending transport, acids are necessarily made close to the place where they are used, and consequently there are a large number of small manufacturers, many of whom are working on too small a scale to be economically efficient. The placing of this industry upon an economic basis is one of the many post-war problems which are already receiving attention. The alternative processes for the synthetic production of ammonia and nitric acid are discussed at length by Mr. Partington.

(3) Mr. Mitchell's book is of a somewhat different type from that of those already considered. It belongs to Sir Edward Thorpe's series of industrial monographs, which aim in particular at showing how fundamental and essential is the relation of principle to practice. Mr. Mitchell's object is to give a concise outline of the chemical composition and properties of the more important oils and fats. In this he has been successful, and the analytical sections will be found very useful, in spite of the fact that there are several satisfactory works on this section of the subject already in existence. It is more difficult, however, to justify the application of the title "industrial." A description is given of the methods of pressing and extracting oils from the crude materials, and of purifying and preparing them for food purposes; but this is very brief, and no attempt is made to discuss the many chemical problems which arise in the oil and fat industry. An altogether inadequate picture is given of the present state of the utilisation of science in the manufacture of edible oils.

The very full bibliography is one of the best features of the book; it is conveniently divided into sections. E. F. ARMSTRONG.

(*To be continued.*)

THE "KEW BULLETIN."

Royal Botanic Gardens, Kew. Bulletin of Miscellaneous Information, 1917. Pp. iv + 349 + 36. (London: H.M.S.O., 1917.) Price 4*s*. 6*d*. net.

THE present volume of the *Kew Bulletin* is an effective rebuke to those in authority who for a time were able to deprive the leading botanical station of the Empire of its means of publication. It would seem an axiom of common sense that a scientific institution carrying out work of prime economic importance should be able to put on record and render as widely available as possible the results of its work.

The subject-matter of the volume was published in seven parts during the past year, and comprises thirty-seven articles of varied interest. The most important is a List of Economic Plants, native or suitable for cultivation in the British Empire, which formed a double number issued last December. This list was prepared in response to a suggestion from the Committee of the Botanical Section of the British Association that a more extended and thorough study of our economic plants was a matter of national and imperial importance. The plants are classified under their uses—such as oils, gums, rubber, drugs, timber, etc.; the source is indicated, and some useful information on the product is also given, with references to publications where fuller information may be obtained.

Other articles of economic importance deal with the rubber plant, *Hevea brasiliensis*; in two are discussed the possible methods of increasing the percentage yield of rubber by seed-selection, as was done in the cultivation of cinchona, in which the percentage yield of quinine has been more than doubled. Another deals with one of the most serious diseases to which this rubber-tree is subject—bark-canker, caused by a fungus, *Phytophthora Faberi*; the writer, Mr. A. Sharples, Government mycologist in the Federated Malay States, finds that the present position is most unsatisfactory, and that the subject calls for careful and co-ordinated investigation.

A general systematic review of the species of the genus Strychnos, native in India and the East, is a valuable contribution, by Capt. A. W. Hill, to our knowledge of a genus which yields two drugs of such importance as strychnine and brucine. A useful communication on the study of plant diseases is embodied in Mr. W. B. Brierley's account of the action of the fungus *Botrytis cinerea* in causing the death of a tree of *Aesculus Pavia* in the Royal Botanic Gardens. There are also several articles embodying the results of the systematic botanical work of the Kew Herbarium; and a short note of more general interest on the flora of the Somme battlefield (abridged in NATURE of February 14 last). A number of miscellaneous notes contain items of economic or general or special botanical interest.

THE MAP AS A NEW EDUCATIONAL INSTRUMENT.

Map Work. By Major V. Seymour Bryant and Lieut. T. H. Hughes. Pp. 174. (Oxford: At the Clarendon Press, 1918.) Price 5*s.* net.

AFTER reading through "Map Work," one is drawn back irresistibly to the Introduction, in which the authors direct attention to the great value of map work both in its utilitarian and its educational aspects, and put forward a convincing claim for its inclusion in the school curriculum. Even in the narrow work of the school itself it provides material for the better understanding of mathematics, geography, and history, the last-named being a subject which demands a much greater appreciation of the relief map than is usually conceded; it gives exercise in the various branches of "drawing," and lastly it gives a rational and legitimate stimulus for the getting of accuracy.

In a wider sense it provides a congenial method of education to many for whom the ordinary school subjects hold little that is attractive when the period of adolescence is reached; and now that we are soon to be faced with a considerable influx of adolescents drawn from schools of widely differing aims and attainments, and where the examinational aspect of the various subjects has not been catered for to any great extent, it will be necesary to open up new avenues of attractiveness, and map work is certainly one of those that should have serious consideration.

Finally, there is the question of the understanding of the landscape by the ordinary layman. Generally this is held to be the domain of the artist. The foreground can be made to fit the map by most people, but the background is too often "blue hills" or "purple mountains," interesting as part of a picture, but otherwise a formless and meaningless confusion.

Map-making, in conjunction with the seemingly difficult, though really simple, art of panorama-sketching, should provide a sure method of introducing form and meaning into the landscape.

The principal aim of "Map Work" is to teach map-reading by means of map-making. Generally speaking, it bridges the gulf that exists between the very elementary work of the practical geographies on one hand, and the technical treatises of the professional surveyor and map-maker on the other. It is suitable for O.T.C.'s and cadet units and for the Oxford Senior Locals, but its value to the general student is very great indeed. Only the topographical map is dealt with, more especially the Ordnance map, but every aspect of this map is adequately and concisely treated, with special chapters on the various methods of surveying, map enlargement, field-sketching, and panorama-sketching. The appendices, which are of considerable length, give an excellent scheme of practical work with much valuable information on the use of materials and the making and use of apparatus. The whole has been read by Col. Close, of the Ordnance Survey, and is full of practical suggestions.

There is one further suggestion that might be made in regard to setting the map by the sun. If the pin or pencil used to cast the shadow be held at an angle, approximately that of the latitude, a better result is obtained than by holding it vertically.

E. J. ORFORD.

OUR BOOKSHELF.

Flora of the Presidency of Madras. By J. S. Gamble. Part ii. Pp. 201–390. (London: Adlard and Son and West Newman, Ltd., 1918.) Price 8*s.* net.

THE second part of the flora of the Presidency of Madras has followed fairly soon on the first, and, like its predecessor, has been very carefully prepared. The natural families dealt with are all those from the Celastræcæ to the end of the Papilionatæ sub-family of the Leguminosæ.

As with the previous part, there is a careful description of each natural family, including details of fruits and seeds, and this is followed by a key to the various genera. Each genus likewise is furnished with a full description and followed by a thoroughly comprehensive key to the several species. These specific keys, together with the ample generic description, convey so much information about the different plants that only a line or two of description are needed under each species in addition to the particulars about its habitat, local name, etc.

The flora, it will be noticed, contains several new species which have been discovered by Mr. Gamble in his re-examination of the material at his command. The majority of the new species have been previously described in the *Kew Bulletin.*

The war has naturally hampered the preparation of the flora, and unfortunately prevented the valuable Madras collections from being sent home for examination. For this second part, however, the Calcutta specimens have been available, as well as the extensive collections at Kew and elsewhere.

For the third part Mr. Gamble proposes to work through the material available in this country, which fortunately is plentiful, as it will not be possible to receive further supplies of specimens from India. The flora is so clear and well arranged that it ought to prove of great value in Madras.

A Complete Course of Volumetric Analysis for Middle and Higher Forms of Schools. By W. T. Boone. Pp. viii+164. (London: Blackie and Son, Ltd., 1918.) Price 3s. 6d. net.

IT is generally recognised that a well-planned course of chemical analysis by volumetric processes provides good intellectual and manipulative training in scientific methods. Careful thought, clear reasoning, and habits of accuracy are fostered by it. One may hope, indeed, that the time is not far distant when all students in our public schools, whether on the "classical" or on the "modern" side, will receive some such training as a normal part of their education, apart altogether from any question of a contemplated career in chemistry.

For such a course Mr. Boone's little book supplies an excellent basis. It "begins at the beginning," and leads the student on by easy but educative stages to quite advanced work. The numerous exercises are very well devised, and ample directions and explanations are given. A useful feature is the interspersed questions on points suggested by the experiments: they focus the learner's attention on matters of special importance. The experiments include the preparation of indicators and standard solutions, as well as analytical exercises; and there is a chapter, short and sufficiently simple, explaining the behaviour of indicators on the usual theory of ionic dissociation. The book can be confidently recommended. C. S.

The Statesman's Year Book, 1918. Edited by Sir J. Scott Keltie, assisted by Dr. M. Epstein. Pp. xlviii+1488. (London: Macmillan and Co., Ltd., 1918.) Price 18s. net.

THIS ever-welcome annual contains the usual familiar features. The bibliographies have been brought, so far as is possible, up to date. Some of this statistical material "cannot be given," other parts are "provisional," for obvious reasons; but an effort has been made to cope with the abnormal conditions. A notable conspectus of the world's pre-war traffic in foodstuffs is provided in a folding map showing relative exports and imports. From an inset diagram we learn that the United States food production just equalled the requirements of the country; only Russia, Canada, and Argentina produced an excess; while the United Kingdom provided for just above half the required quantities of foodstuffs; though Canada is given, Australia is omitted. Among the introductory tables we note one dealing with sugar. During the war the world's supply of sugar has decreased by 20 per cent.; the production of sugar from the sugar-beet declined by more than 40 per cent., that from the cane has grown by 20 per cent., the output from Java having increased by 40 per cent.

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.]*

Auroral Observations in the Antarctic.

IN NATURE for April 11 last Dr. Chree reviewed Sir Douglas Mawson's paper on "Auroral Observations at the Cape Royds Station, Antarctica," and directed attention to the impression the observers received that the aurora was sometimes seen in the lower atmosphere between them and Mount Erebus. A similar statement had appeared in Shackleton's book, "The Heart of the Antarctic" (vol. ii., pp. 360–61), before Scott's expedition left for the South. As this subject is of fundamental importance in all discussions of the origin and nature of the aurora, I arranged with all members of the expedition that I should be called whenever they saw, or thought they saw, an aurora in front of Erebus.

Observations of this phenomenon were made on three occasions, and luckily I was at hand each time. I reproduce here, verbatim, the notes I made immediately after each occurrence:—

"(a) *May* 21, 1911.—This evening there was a bright aurora, and word came in to me that the aurora beams were clearly visible between here and Erebus. On

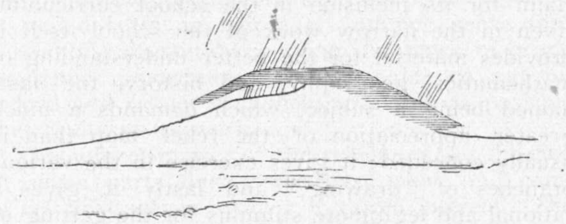


FIG. 1.

going out it appeared for some moments that this was so, but on looking closely I came to the conclusion that the effect was an illusion. The moon was low in the south, and only one or two shoulders of Erebus were lit up by it; these, however, formed more or less clear bands of light from top to bottom of the mountain. When the aurora was bright above the mountain these moonlight bands appeared as continuations of the aurora beams, and it was quite easy to imagine them in motion owing to the bright and rapid motion of the aurora itself. Dr. Wilson agreed with me in this explanation, but Dr. Atkinson, Wright, and Ponting continued to hold firmly that they had really seen the aurora in the lower atmosphere this side of the mountain.

"(b) *June* 22, 1911.—At about 21h. 30m. Meares reported an aurora this side of Erebus. On going out to examine, I found that the effect had disappeared; the explanation, however, seemed simple. The top of Erebus was covered with a cloud-cloak, which had an external form almost like that of the mountain. At one side, however, it was incomplete, and no doubt the aurora was seen between the cloud here and the mountain. In the dim light the outline of the cloud was taken to be that of the mountain, so that the aurora appeared to be in front of the mountain. (Fig. 1.)

"(c) *July* 19, 1911.—At 5 a.m. Meares reported to me an aurora in front of Erebus. On going out, there appeared to be a very bright beam of aurora low down on the foothills of the mountain, and obviously well in front of the latter. The explanation was, however, simple. The beam was not an aurora beam at all, but part of the 22° halo with the horizontal mock moon. The illusion was, however, very striking, as there were vertical beams of aurora on the left and above the halo beam." (Fig. 2.)

I have given above the actual words written at the time, as it is dangerous to describe an observation several years later, especially if a matter of opinion is concerned. I feel compelled, however, to add a few further remarks.

With regard to (*a*) it should be realised that as the moon was low, the outlines of the mountain were very indistinct, and the bands of light due to the moon shining on the shoulders were very faint. Normally, they could scarcely be seen, but when an aurora beam above the mountain coincided with a band, the eye was guided down from the beam to the band of light, which then attracted the attention and appeared as a continuation of the aurora beam.

A cloud-cloak similar to that referred to in (*b*) was often observed to cover the top of Erebus, especially after a blizzard. It frequently lay very near to the mountain, and at night its outline would not be distinguishable from that of the mountain. It was only when the gap between the mountain and the cloud, through which the aurora appeared, was observed that the presence of the cloud itself was suspected. This was an excellent illusion, and nine casual observers out of ten would have been convinced that the aurora was clearly visible in front of the mountain.

The third illusion was probably the most impres-

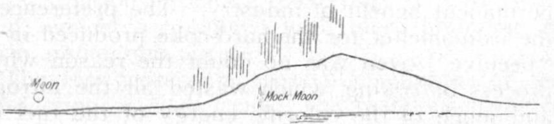


FIG. 2.

sive. The mock moon, with part of the vertical circle, was formed in a mist, itself quite invisible, which lay over the foothills of Erebus. The moon was shining in a clear sky without any sign of a halo, and none but a trained observer would have connected this detached beam of light with the moon. It appeared to be much more a part of the aurora display which was taking place apparently in its immediate neighbourhood, and the conclusion reached by Meares that it was a part of the aurora was very natural.

In my paper on "Atmospheric Electricity in High Latitudes" (Phil. Trans., A, vol. ccv., p. 92, 1905), I described another case of an illusion in Lapland, which made the aurora appear underneath low-lying clouds. Thus both in the north and in the south I have seen cases in which the aurora appeared to be in the lower atmosphere, and in all these cases very careful observing was necessary to discover the illusion. The mere statement, therefore, that an aurora has been seen between the observers and a near object cannot be accepted as a proof of the penetration of the aurora into the lower atmosphere. G. C. SIMPSON.

Meteorological Office, Simla, India, June 13.

ELECTRICAL phenomena resembling aurora have hitherto been observed in the laboratory only at very low atmospheric pressures, and the recent determinations of the altitude of aurora by Prof. Störmer and others have given few heights so low as 50 km. Thus reported observations of aurora below the summits of mountains are naturally viewed with suspicion by physicists. The explanations given by Dr. Simpson of the three cases he describes—the only ones apparently observed during the Scott Antarctic Expedition of 1911–12—are ingenious. But in two cases it is not explicitly stated whether the original observer accepted the proffered explanation, and in the remaining case it appears that, with Dr. Simpson's explanation before them, the majority of the observers remained of their original opinion. Sir Douglas Mawson's list included a greater number of apparent cases of aurora at low altitudes, but whether the observers possessed the exact shade of scepticism desirable in observers in such a case I am unable to say.

My own view is that we are not as yet in a position to deny the possibility of the occurrence of aurora at low levels near the magnetic poles. It is desirable that the observers of the next Arctic or Antarctic expedition should be familiar with what has been written on the subject, and that they should be specially careful in dealing with any apparently low-level aurora. Also observation of auroral heights by photography after Prof. Störmer's method should be a fundamental part of the programme of any such expedition; and while a long base should be used for some of the observations, others should employ a base sufficiently short to deal satisfactorily with heights of only a few kilometres. C. CHREE.

August 17.

Hybrid Sunflowers.

IN crossing the different species and varieties of Helianthus some peculiar results have been obtained. The crosses referred to have all been made by my wife at Boulder, Colorado, and the results may be classified as follows:—

(1) The varieties of *Helianthus annuus* (including *H. lenticularis*, regarded by some botanists as a distinct species) when crossed together produce plants which are as fertile as the parents. In some of the mongrel varieties there is, however, a marked deficiency of pollen.

(2) The annual species of sunflowers (typical Helianthus) crossed together are quite fertile, but the hybrids are themselves nearly sterile. *H. annuus* has been crossed with three species, *H. argophyllus, H. petiolaris*, and *H. cucumerifolius*.

(3) The annual species can rarely be crossed with the perennial, and when this occurs the offspring closely resemble one or the other parent species. One such hybrid was recorded in the "Standard Cyclopedia of Horticulture" (vol. vi., 1917, p. 3281) as between *H. pumilus* and *H. annuus*. Renewed study of the living plants this year convinces me that this is an error; the perennial parent was, in fact, *H. subrhomboideus*. Both species occur here, and Mrs. Cockerell, at the time of making the cross, did not distinguish between them. Morphologically they are especially distinguished by the fact that *H. subrhomboideus* has underground migratory branches, by means of which it spreads, while *H. pumilus* is strictly stationary, reproducing only by seed. The hybrid, which closely resembles *H. subrhomboideus* (though this was the pollen parent), but is much larger, with larger broad leaves, has small or short underground branches, but, nevertheless, is stationary. That is to say, the migrators are present, but the plant does not spread by them in all directions as do the true migratory forms. Comparing the details of structure, I found that the ray-florets of the hybrid were quite without pistils, whereas these were well developed (though not functional) in the *H. subrhomboideus*. However, further investigation showed, to my surprise, that some heads of the wild *H. subrhomboideus* had the ray-florets wholly without pistils. The involu-

cral bracts of the hybrid are more distinctly pointed than those of *H. subrhomboideus*. In other cases attempts to cross annuals with perennials have resulted in total failure, as has happened when crossing *H. annuus* on *H. pumilus*, in attempts to repeat the cross described above, which was erroneously interpreted. In other cases seeds were obtained from the pollen of perennials used on annuals, and the resulting plants were indistinguishable from the annual parent. Seeds received from Mr. L. Sutton from England, representing the F_2 of a cross between the red *H. annuus* and the perennial *H. rigidus*, also gave plants entirely of the *annuus* type.

Babcock and Clausen, in their recent (1918) admirable work, "Genetics in Relation to Agriculture," have (chap. xii.) discussed those remarkable cases in which the F_2 generation of a cross gives plants resembling the original species crossed, with greater or less fertility. A very ingenious and plausible explanation is given. Collins and Kempton recently found that in crossing two distinct genera of grasses, Tripsacum and Euchlæna, they obtained plants agreeing with the pollen parent, the Euchlæna. They call this patrogenesis (*Journal of Heredity*, vol. vii., No. 3, 1916). One of the explanations offered by them is that the male nucleus may have developed in the ovary to the complete exclusion of the female, "representing in a way the counterpart of parthenogenesis." It appears quite possible that in some hybrids, and perhaps other heterozygous forms, particular pairs of homologous determiners do not both function or develop, so that *in respect to certain characters the organism is simplex*, not in the sense of the old "presence and absence theory," but in the sense of not being a hybrid at all in respect to particular features.

T. D. A. COCKERELL.

University of Colorado, Boulder, Colorado, August 6.

THE NITROGEN PROBLEM IN RELATION TO THE WAR.

PROF. ARTHUR A. NOYES, of the Massachusetts Institute of Technology, who is chairman of the Committee on Nitrate Investigations of the National Research Council of America —a body which owes its existence to the war— recently delivered a lecture before a joint meeting of the Washington Academy of Sciences and the Chemical Society of Washington, a report of which, under the above title, is published in the Journal of the Washington Academy of Sciences for June 19. The lecture dealt with the vital importance of an adequate supply of nitrogen compounds, particularly of nitric acid and ammonia, in connection with the war, and gave a brief description of the various efforts America was making in order to meet the demand. Nitric acid enters, directly or indirectly, into the composition of all the more important explosives, such as smokeless powder, picric acid, ordinary black powder, dynamite, trinitrotoluol, and ammonium nitrate. The last-named substance is now used on so enormous a scale that the demand for ammonia is scarcely less urgent than that for nitric acid.

The main sources of these two nitrogen compounds are: (1) Chile saltpetre; (2) by-product gas from coke-ovens; (3) atmospheric nitrogen, which is "fixed" by (*a*) the cyanamide process, (*b*) the cyanide process, (*c*) the arc process, and (*d*) the synthetic process.

For its supply of nitric acid the United States, like ourselves, has hitherto mainly depended upon imported sodium nitrate (Chile saltpetre), which is now recognised as a rather precarious source, as it depends upon adequate shipping, and is liable to be affected by enemy machinations in interfering with production, destroying plants, or blowing up the reservoirs of oil needed for fuel. Hitherto all attempts on the part of the enemy to establish a submarine base on the Pacific Coast have been foiled. But even if this source continues to be efficiently safeguarded, America realises that it is impracticable to get through imported nitrate the huge amount of nitric acid that will be needed for her Army, and that it will be necessary to supplement this supply by other means.

The demand for ammonia has led, as with us, to a complete revolution in coke-oven practice, and the old wasteful "beehive" oven is rapidly becoming a thing of the past. "By-product" ovens, in which the coal to be coked is heated in what are practically closed retorts, and the evolved gases passed through scrubbers and condensers whereby the ammonia and inflammable gases are recovered and utilised, are, under the spur of necessity, being everywhere established, to the permanent benefit of industry. The preference of the iron-smelter for the hard-coke produced in the "beehive" oven was no doubt the reason why a process of coking which wasted all the nitrogen and much of the calorific energy of the fuel has continued so long, both here and in America. The war, however, has effectually broken down what is, after all, a prejudice, and there can be little doubt that "by-product" coking will shortly become the universal practice. Indeed, it is now a question of practical politics whether, in the interests of national economy, the employment of "by-product" ovens in coking, to the exclusion of the old form, should not be made compulsory. So urgent is the demand for ammonia in connection with the war that Germany is incidentally producing far more coke than she can use immediately, either in metallurgy or as fuel, and enormous stocks are being accumulated.

As regards "fixation" processes, America is now working, to a greater or less extent, all the methods which have been developed during the past fifteen years. Even before the war the American Cyanamid Co. at Niagara Falls was producing about 20,000 tons of cyanamide a year, largely for use in agriculture. By the action of steam upon this substance it is practicable to get substantially all the original nitrogen in the form of ammonia. This process is capable of a great extension, and has already reached considerable proportions in Germany, where it competes with the Haber process. The American Government is building a cyanamide plant with a capacity of 110,000 tons of ammonium nitrate at Muscle Shoals, Alabama, and a third plant has been authorised for the production of another 110,000 tons in Ohio. The cyanamide process has the advantage that it can be installed in many places in the country, and that it requires little power. It has probably a great future before it—certainly immediately—but whether it is ultimately destined to be supplanted by the synthetic process time alone can show.

The cyanide method is still in process of development, and is carried out in various ways. Several concerns are working it, among them the Nitrogen Products Co. at Saltville, Virginia, and the Air Reduction Co., and the Government is also building a plant. The product first formed is sodium cyanide, which, as in the case of cyanamide, can be made to yield ammonia under the action of steam. Sodium cyanide is, however, so valuable as a metallurgical adjunct that it will not pay to convert it into ammonia until the market for cyanide has been satisfied.

The synthetic process was already worked in America by the General Chemical Co. before the outbreak of war, and it had so far perfected the process—well beyond the point which the Germans had reached—that it was able to operate at lower temperatures and pressures. The Government has taken over the process of the company, and is now working it at Sheffield, Alabama, with a plant capable of producing 20,000 tons of ammonium nitrate per annum. A portion of the ammonia produced is put through the oxidation process, converting it into nitric acid, which is combined with more ammonia to form ammonium nitrate.

The arc process is especially suitable for the production of nitric acid. The reactions involved are chemically very simple, but they need a large amount of energy, which, under American conditions, would be very expensive to produce. By recent agreements with the Norwegian Government the United States and the Allies will receive about 112,000 metric tons of calcium nitrate per annum, made by the arc process, as against the limit of 8000 tons sent to Germany. As matters stand it is very unlikely that the arc process will obtain any very extensive application in America.

Prof. Noyes concludes his lecture with some remarks upon the relative economies of the different processes, but the conditions at present are so abnormal that it is impossible to make any very definite statements as to their ultimate commercial prospects. In the meantime the Government is using all its resources, expanding its imports of Chile saltpetre, introducing as rapidly as possible "by-product" coke-ovens, and developing new fixation processes through the Nitrate Division of the Ordnance Department with the co-operation of the Bureau of Mines.

The oxidation process of turning ammonia into nitric acid has been so far perfected that a conversion of from 92 to 95 per cent. is now possible, and the process of absorption of the nitric vapours has been much simplified. It is certain that, as one result of the war, there will be a very marked development in the States within the next year or two of American processes of nitrogen fixation.

INDIGO IN BIHAR.

AN account of the recent history and present position of indigo in Bihar, by Mr. W. A. Davis, indigo research chemist to the Government of India, was reviewed in NATURE of July 18 last. In two further communications Mr. Davis has discussed the future cultural prospects of the industry,[1] outlined the difficulties to be surmounted if success is to be attained, and detailed the conclusions indicated by a study of Bihar indigo-soils.[2]

Among the various factors—careful seed-selection, improved cultivation, better manufacture, and sounder business organisation—on which the fate of natural indigo depends, the most urgent is the cultural. The evidence presented indicates that the indigo-soils of Bihar have been steadily losing fertility through exhaustion of their available phosphate. This conclusion is based on the results of actual soil-analyses, the success with indigo grown outside Bihar in soils still containing adequate available phosphate, and the response of indigo within Bihar to the manurial use of superphosphate.

The treatment appropriate for *Indigofera sumatrana*, until 1898 the indigo exclusively grown in Bihar, does not suit *I. arrecta*, introduced in 1899. After this difficulty was overcome the results with *I. arrecta* appeared to justify the hope that extended cultivation of this new plant might save the natural indigo industry. The product of *I. sumatrana* may no longer be expected to compete successfully against artificial indigo. But actual results, secured in 1906–7, indicate that natural indigo from *I. arrecta* may be manufactured and profitably sold at rates "cutting" the lowest pre-war quotations for synthetic.

The disappointment of this hope is popularly attributed to two blights—*psylla* and "wilt." The entomological malady can scarcely be accounted serious. There is no evidence that *psylla* injures indigo of normal vigour; there is evidence that affected plants which regain thrift may "grow through" and "shake off" *psylla* attack. The "wilt" is not induced by any pathogenic organism; it is the sequel to defective nutrition, explicable by the phosphate-exhaustion now characteristic of Bihar soils.

The remedy then for Bihar is to employ superphosphate. Even so, the only hope for the future lies in the cultivation of *I. arrecta*; that of *I. sumatrana* is contra-indicated on economic grounds. Seed-selection to secure strains of *I. arrecta* rich in indican is also a pressing need. There is doubtless another possibility. Outside Bihar, under climatic conditions hitherto deemed unsuitable for indigo, *I. arrecta* thrives well. It may in time prove more economic to transfer indigo from Bihar to localities with soils sufficiently rich in available phosphate than to transport phosphate to indigo in Bihar.

What lies outside debate is that, if the natural

1 "The Present Position and Future Prospects of the Natural Indigo Industry." By W. A. Davis, Indigo Research Chemist to the Government of India. *Agricultural Journal of India*, vol. xiii., part iii. (July, 1918).

2 "A Study of the Indigo Soils of Bihar." By W. A. Davis. Agricultural Research Institute, Pusa, Indigo Publication No. 1 (1918).

indigo industry is to survive, *I. arrecta* must receive the phosphate it needs. So far as the cultural factor is concerned the future depends upon the indigo grower. Unless he is prepared to supply his plant with the food requisite for its vigorous thrift, and to do this without further demur and delay, the end of the war must mean the end of natural indigo, not in Bihar alone, but throughout India.

NOTES.

We regret to learn that the Natural History Museum is losing the services of Mr. W. R. Ogilvie-Grant, assistant keeper of the department of zoology and head of the Bird Room, who has been compelled to relinquish his appointment owing to continued ill-health. Mr. Grant has served in the museum for thirty-six years, having entered the department as an assistant in the year 1882. He is the author of the official catalogue of the game-birds, and joint author with the late Dr. R. Bowdler Sharpe of two other volumes of the great British Museum Catalogue of Birds. Mr. Grant was for many years editor of the Bulletin of the British Ornithologists' Club, and he carries with him in his retirement from official harness the good wishes and esteem of his many friends and brother ornithologists.

We learn from the Journal of the Washington Academy of Sciences that Dr. Cleveland Abbe, meteorologist of the U.S. Weather Bureau, and editor of the *Monthly Weather Review*, has been removed from his positions, the reason given being his "long-standing and generally well-known friendly sympathies for the Imperial German Government." It is stated that Dr. Abbe has denied disloyalty, and asked to be given an opportunity to reply to any charges presented.

Prof. C. A. Pekelharing has retired from the chair of physiological chemistry in the University of Utrecht, and has been succeeded by Dr. W. E. Ringer, one of his former assistants, and originally an inorganic chemist.

According to the *Nieuwe Courant* of August 24, Prof. Haeckel's house at Jena, Villa Medusa, will be transformed into a Haeckel museum and presented to the University. It will contain Haeckel's extensive collections, and be combined with an institute for general developmental theory. The Carl Zeiss foundation is giving financial aid.

The *Times* announces that Mr. V. Stefansson, the leader of the Canadian Arctic Expedition, has arrived at Dawson on his way to Ottawa. Mr. Stefansson's expedition left Esquimault in the summer of 1913 to explore the Beaufort Sea and adjacent islands of the Canadian Arctic Archipelago. It will be remembered that his chief vessel, the *Karluk*, was crushed in the ice in January, 1914. Three members of the expedition lost their lives on that occasion, Dr. Forbes Mackay, Mr. James Murray, and M. Henri Beuchat. Mr. Stefansson, with several members of his staff, was ashore at the time the *Karluk* broke adrift, and he continued the work of the expedition. The southern party, under the leadership of Mr. R. M. Anderson, returned in the autumn of 1916 after doing a considerable amount of work in the Mackenzie delta and the coast of the mainland to the east. Mr. Stefansson himself discovered new land north of Prince Patrick Island in June, 1915, and further land north-west of Banks Land in 1916. No news of his discoveries since that date has yet been announced, but Mr. Stefansson has probably been engaged in extending his explorations, in surveying his discoveries, and in studying the Eskimo. He announces that he intends to return to the Arctic in a year's time. There has been no news of Mr. Storkersen, a member of the expedition, who, with three Eskimo, left Herschell Island last winter in an attempt to reach Melville Island across the sea-ice, since April last, when he sent back word that he had gained a point 175 miles north of the Alaskan coast.

We regret to record the death of Lord Forrest, which occurred at sea last week on his voyage from Australia to England. Lord Forrest, better known as Sir John Forrest, was born in Australia of Scottish parents in 1847. He entered the Survey Department of Western Australia in 1865. In 1869 he undertook to search for traces of the German explorer Leichhardt. Though he failed in the main object of his expedition, Forrest made many discoveries. In 1870 he explored the south coast of Australia from Perth to Adelaide, and in 1874 he accomplished a journey through the heart of Western Australia. Starting from Champion Bay, he struck north-east to the Murchison River, which he followed to the Robinson Ranges, and then went along the 26th parallel to Peake Station on the overland telegraph, where he turned south and reached Adelaide. This remarkable journey of about 2000 miles was accomplished in five months, and proved that the interior of the colony was useless for settlement. In succeeding years Forrest surveyed the country between Ashburton and Lady Grey Rivers, and the Fitzroy district. From 1883 to 1890 he was Surveyor-General of Western Australia, and in 1890 became Premier. In 1901 he joined the Commonwealth Government, and served successively in several capacities. He had been a ceaseless advocate of a transcontinental railway, and regarded the completion of the line from Perth to Adelaide as the triumph of his political career. Lord Forrest was a gold medallist of the Royal Geographical Society and an LL.D. of Cambridge, Adelaide, and Perth.

By the death of Sir Ratan Tata, which occurred on September 5, at the age of forty-seven, a notable figure in the industrial and philanthropic life of India and England has disappeared. The son of Mr. Jamsetjee N. Tata, the well-known Parsi capitalist of Bombay, he married the daughter of Ardesir Merwanji Seth, the head of the priestly community of the Bombay Parsis. Mr. Jamsetjee N. Tata, who died in 1904, had planned various industrial enterprises, which he left to his sons, Sir Dorab Tata and Sir Ratan Tata, to bring to completion. One of these schemes was the establishment at Mysore of the Indian Institute of Research for the promotion of scientific, medical, and philosophical studies. His sons carried out his intentions, and provided a liberal endowment for the institute. Sir Ratan Tata's fame rests on his development of the Indian steel and iron works, for which the preliminary investigations were made at his expense by a staff of European and American experts. He and his brother, Sir Dorab Tata, carried out this enterprise, and founded the great metal works at Sakchi, the capital of which amounts to some millions sterling. Another scheme due to the brothers was to store and utilise the heavy rainfall of the Western Ghats for the supply of cheap and abundant electrical energy at Bombay, a work which has few parallels in other parts of the world. Sir Ratan Tata had long resided at York House, Twickenham, and at Versailles. In London he was deeply interested in scientific and philanthropic projects. He founded the Ratan Tata Department of

Social Science and Administration in the London School of Economics, and he established a fund of 1400*l.* per annum for the study of means to prevent and relieve destitution. He supported the Indian Moderate Party's programme of political reform in India, and received the honour of knighthood in 1916. It is fortunate that Sir Ratan's industrial enterprises are now under the competent supervision of his brother, Sir Dorab Tata.

THE death is announced, at the age of sixty years, of Dr. J. Harper Long, professor of chemistry at the North-Western University Medical School, Chicago, and a former president of the American Chemical Society.

THE recent death of Mr. W. Francis de Vismes Kane, of Drumreaske, Monaghan, Ireland, at the age of seventy-eight, is announced in the *Irish Naturalist* for July. Mr. Kane was well known to entomologists through his "Handbook of European Butterflies" (1885) and his "Catalogue of the Lepidoptera of Ireland" (1901), but his scientific interests were wide, as he attained distinction also as a student of the freshwater Entomostraca and of prehistoric archæology.

NEWS has just been received that Lieut. L. J. F. Oertling, who was reported missing on August 8, died on that date from wounds received in action. Lieut. Oertling was in the twenty-seventh year of his age, and was educated at Clifton College, afterwards entering the business of his father, Mr. Henry Oertling, the well-known manufacturer of chemical and other types of balances. He joined the Inns of Courts O.T.C. shortly after the outbreak of war, and obtained a commission in the Bedfordshire Regiment (T.), proceeding to France with the 8th Battalion. Eventually he became attached to the Royal Flying Corps.

PROF. FRASER HARRIS has now completed the history of the medical aspect of the great disaster at Halifax, N.S., on December 6, 1917. It is expected that the history and its appendices will be published under the auspices of the Halifax Relief Commission, a body appointed by the Canadian Government to take over the care of all matters arising out of the disaster.

THE Faraday Society has again arranged for a series of general discussions of important scientific subjects during the coming session. On November 4 the subject of discussion will be the occlusion of gases by metals; and that at the December meeting will be the present position of the electrolytic dissociation theory. After the New Year, discussions will be held on catalysis, the theory of flotation processes, and the scientific use of fuel. All these subjects are of wide interest on both the industrial and the scientific sides, and their discussion by competent authorities should have a stimulating influence upon their development. Communications are invited from investigators who have devoted particular attention to any of the subjects in the programme. The address of the society is 82 Victoria Street, S.W.1.

THE sixth annual meeting of the Indian Science Congress will be held in Bombay from January 13 to 18 next, under the patronage of Lord Willingdon, the Governor of Bombay, and the presidency of Sir Leonard Rogers, F.R.S. The sections and their presidents will be:—Applied Botany and Agriculture, the Hon. G. F. Keatinge; Physics and Mathematics, Dr. D. N. Mallik; Chemistry, Mr. F. L. Usher; Systematic Botany, Mr. S. R. Kashyap; Zoology, Mr. S. W. Kemp; Geology, Dr. L. L. Fermor; and Medical Research, Lt.-Col. Glen Liston. Further particulars of the meeting may be obtained from the hon. secretary, Dr. J. L. Simonsen, Indian Munitions Board, Simla.

AN editorial article in the *Geographical Journal* for September (vol. lii., No. 3) discusses some important points in the nomenclature of Himalayan peaks. It is the practice of the Survey of India to veto all names and employ only numbers to designate peaks. Mount Everest is the only exception. Even Godwin-Austen is not allowed in place of K^2 or its modern synonym Pk. 13/52A. Most of the peaks have no native names, and the difficulty in giving names seems to lie in finding ones that will harmonise with such as exist. The Survey of India rightly objects to trivial names which are out of keeping with the ranges as a whole. Cathedral Peak, Broad Peak, and so forth may be appropriate locally, but are unsuitable continentally, and in any case are not specific. The numbering of peaks on the system now adopted has the merit of indicating the degree-sheet on which the peak occurs. In the example cited above, 52A is the number of the degree-sheet and 13 the number of the peak. On the other hand, the system has obvious defects, the greatest, perhaps, being that numbers are difficult to remember, and give anonymity to the peaks. Mr. Hinks suggests eight figure-numbers giving latitude and longitude. That would involve greater precision, if a severer test of the memory, but introduces complications where two peaks lie close together and seconds have to be added. No doubt in time many of these peaks will receive names, despite official disapproval.

IN the July issue of the Journal of the Land Agents' Society there appears an article on "Wild Birds and Legislation," by Dr. W. E. Collinge. Although there will not be general agreement with the author in his conclusions that the question of wild-bird protection has never received really serious consideration, that the majority of the Wild Birds' Protection Acts have been ill-considered, and that no attempt has been made by those who advocate the protection of wild birds to understand the problems presented by wild-life, yet we thoroughly endorse his opinion that there is immediate need for a new and comprehensive Act—one that would afford protection to rare and vanishing species as well as to those birds which are beneficial, and would at the same time allow for the taking of adequate repressive measures against those species which are destructive and have become too numerous. As a matter of fact, a Departmental Committee was appointed by the Home Secretary in 1913 to consider what amendment in the law relating to wild birds and its administration might be required. This Committee held a number of meetings at which such questions as those raised by Dr. Collinge were freely discussed and considered, and many witnesses, representing all parties interested, were examined. The war, unfortunately, put a stop to the deliberations of the Committee, but it is to be hoped that when the Committee next meets it will be able to suggest lines on which a new Wild Birds' Protection Act, applicable to the whole of the British Isles, should be framed to replace the Act at present in force, with its perplexing supplementary Acts and the local Orders issued under them. The economic status of birds is now fully recognised, and it is high time that there should be created an Ornithological Bureau, similar in function to that long since established in the United States of America. To such a bureau should be referred all matters in connection with the administration of the Wild Birds' Protection Act, and the consideration of such modifications as may be necessary to meet special and local conditions.

THE American Museum of Natural History (New York) has just issued, as the first article of vol. xxxix. of its Bulletin, "A Revision of the Vespidæ of the Belgian Congo," by J. Bequaert. This is a systematic paper of more than usual importance, the generic and specific diagnoses being exceptionally detailed and carefully illustrated by structural drawings and coloured plates, and the classificatory facts being illuminated by many notes on behaviour and by valuable geographical discussions, with many distributional maps. It is pleasant to read in the author's introduction that when conditions in Europe deprived him of the fruits of all but a small part of his own collecting, he found ample materials for study in "the splendid collections of the American Museum Congo Expedition," as well as a hearty welcome and cordial assistance from the naturalists of the United States. From the same institution has been issued as a "Guide Leaflet" (No. 48) a popular pamphlet by C. E. A. Winslow and F. E. Lutz on "Insects and Disease." The facts and methods of germ-transmission by insects are clearly set forth, and illustrated by good photographs of specimens and models exhibited in the American Museum.

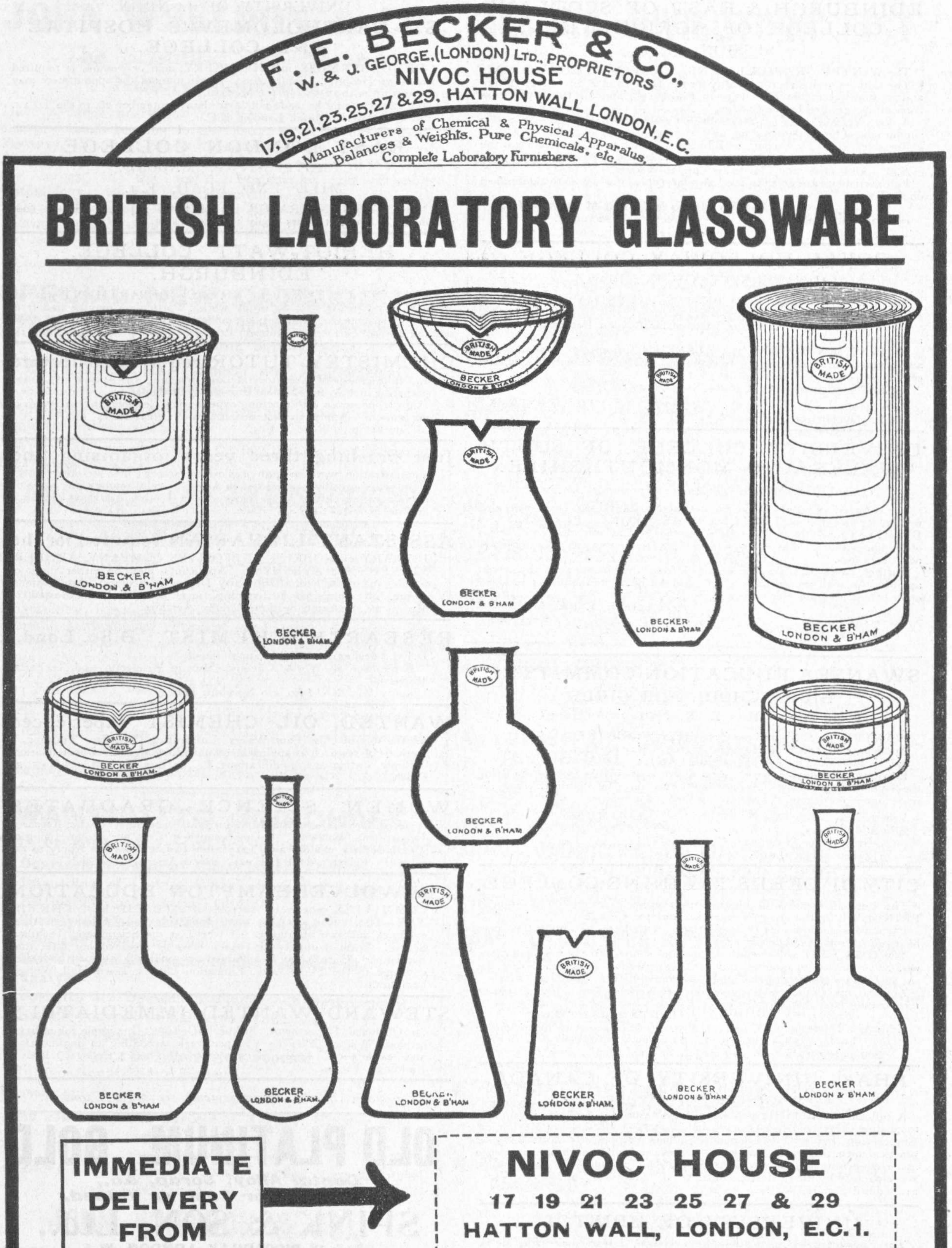
IN the latest part of the *Science Reports* of the Tohôku Imperial University, Japan (Second Series, Geology, vol. iii., No. ii., 1918), Prof. H. Matsumoto has several interesting notes on the fossil mammals of Japan. A new molar tooth of an elephant from Kaza seems to be exactly intermediate between the molars of Elephas and Stegodon. Part of the lower jaw of an ancestral deer, probably of Lower Miocene age, is referred to a new species of Amphitragulus, and is unusually large. An elaborate study of some skulls and frontlets of bison from the Pleistocene of Japan shows that they belong to the extinct species *Bison occidentalis* and *B. crassicornis*, which are already known from North America (chiefly Alaska) and Siberia. A discussion of the skull and teeth of the remarkable Miocene sirenian Desmostylus is especially valuable. Good specimens have now been obtained both from the Pacific coast of North America and from Japan, so that instructive comparisons can be made. The Japanese species is the largest sirenian known, with a skull 90 cm. in length. It seems to have frequented estuaries rather than open seas, and its peculiar front teeth were probably used like those of a hippopotamus to dig up nutritious plants from mud. The molars are especially effective grinding teeth, and are sufficiently deepened to last during a long life.

PROF. CHAS. CHILTON, who described the first species of Phreatoicus in 1883, has added an interesting chapter to the history of this crustacean genus by giving a description (Journ. Proc. Roy. Soc. N.S. Wales, vol. li., pp. 365–88, 1918) of a fossil species based on ten impressions found in the Wianamatta Shale (probably Upper Trias) of Queensland. Although none of the specimens are complete, the head and the first peræopods not being clearly represented in any of them, the evidence afforded by the remainder of the animal, which is in a good state of preservation, leaves no doubt as to the correctness of the identification. The fossil species, described as new under the name *Phreatoicus wianamattensis*, was similar in general appearance to *P. australis*, and reached a length of 30 mm. The living members of the Phreatoicidea, a primitive group of the Isopoda, are found in the fresh waters of Australia, Tasmania, New Zealand, and South Africa.

THE Geological Survey of Hungary has published the first volume of a new serial named *Geologica Hungarica*. It is a handsome quarto of 450 pages in the Magyar language, and is well illustrated by 275 text-figures and 26 plates of fossils. It comprises three parts, dealing respectively with Oligocene Mollusca, Tertiary Echinoids, and Callovian Ammonites. The last part is by the director of the survey, Dr. L. Loczy, and concludes with a valuable stratigraphical table showing the various Hungarian equivalents of the Lower and Middle Oolites of western Europe.

THE past summer has, for the most part, been agreeable and pleasant from a meteorological point of view, although the totals and averages of the several elements, and of the rainfall especially, have been liable to mislead and to give a somewhat unsatisfactory impression. Some of the meteorological happenings were abnormal, but they have, on the whole, proved to be an advantage. Combined records for the three months, June, July, and August, show a general deficiency of rain except in the north of Scotland and in the south-east of England. In the neighbourhood of London the aggregate rainfall for the three months was about 9 in., which is nearly 2·5 in. more than the normal, although about 2 in. less than in 1917, and it has only been exceeded in one other summer, 1903, since 1890, in twenty-eight years. June had a decided deficiency of rain over the British Isles, and chiefly so in England, where it was mostly less than 50 per cent. of the average, but July was excessively wet, yielding generally over the kingdom an excess of nearly 50 per cent. of the average, whilst August has yielded a total far below the normal. In July thunderstorms were phenomenal over England, and at Kew Observatory they occurred on nine days, being more frequent than in any July since 1880. In London the mean temperature for the summer was 61·5°, the mean maximum reading being 10° higher and the mean minimum 10° lower than the mean temperature, these results being not very different from the average, but, on the whole, there has been an absence of hot days. Sharp ground-frosts occurred in many parts of England, especially in the eastern, central, and south-eastern districts, on several occasions in June, and their effects are distinctly traceable. Over the country generally there has been during the summer a slight deficiency of temperature. The sunshine has not differed very materially from the average.

THE *Cairo Scientific Journal* (vol. ix., No. 100, January to March, 1917) contains an account by the late Prof. Kr. Birkeland of simultaneous observations of the zodiacal light by himself and an assistant, the one at Helwan in Egypt, the other at Salisbury in Southern Rhodesia. The stations possessed the same longitude, 31° E. of Greenwich, while differing nearly 48° in latitude. The observations discussed were made on sixteen occasions between July 8 and September 2, 1915, but the results are treated as preliminary, the hope being expressed of repeating them at more suitable stations at a more favourable season, adopting an improved photographic method. The observational results are shown in a number of figures, and it is claimed that they show two definite results—first, that the height of the visible light column was much greater at Salisbury than at Helwan, and, secondly, that there was a considerable relative displacement of the light columns, to the north at Helwan, to the south at Salisbury. There are numerous references to Prof. Birkeland's theoretical views, which associate the zodiacal light with the earth's magnetism. He apparently believed in the existence of "a *principal* ray system, a lenticular nebula round the sun which scatters the sunlight, and of a *secondary* scattering ray system round the earth, captured from the principal solar system by the earth's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EDINBURGH & EAST OF SCOTLAND COLLEGE OF AGRICULTURE.

SESSION 1918–19.

The WINTER SESSION BEGINS on TUESDAY, OCTOBER 8.

The Courses of Instruction qualify for the Degrees of B.Sc. in Agriculture and in Forestry of the University of Edinburgh, and for the Diploma in Agriculture granted by the College.

A Two Years' Course for the College Certificate in Horticulture, and a similar course for students taking up Dairying, are also available.

Bursaries given by Secondary Education Committees are tenable at the College.

N.B.—All Courses and Classes are open to Women.

Full particulars are given in the Calendar, copies of which may be obtained on application.

ALEXANDER M'CALLUM, M.A., LL.B., Director and Secretary.

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ROYAL HOLLOWAY COLLEGE.

(UNIVERSITY OF LONDON.)

The MICHAELMAS TERM BEGINS THURSDAY, OCTOBER 3, 1918.

The College Prepares Women Students for London Degrees in Science and Arts.

TWELVE ENTRANCE SCHOLARSHIPS, from £50 to £60 a year, and several Bursaries of not more than £30, tenable for three years, will be offered for competition in June, 1919.

For further particulars apply to the SECRETARY.

Royal Holloway College, Englefield Green, Surrey.

UNIVERSITY COLLEGE OF SOUTH WALES AND MONMOUTHSHIRE.

Coleg Prifathrofaol Deheudir Cymru a Mynwy.

The Council of the College invites applications from both men and women for the post of TEMPORARY ASSISTANT LECTURER and DEMONSTRATOR in PHYSICS for the Michaelmas and Lent Terms of Session 1918–19. The salary will be £100 for the two terms, with certain additional fees.

Further particulars may be obtained from the undersigned, by whom applications, with testimonials (which need not be printed), must be received on or before Monday, September 16, 1918.

D. J. A. BROWN, Registrar.

University College, Cathays Park, Cardiff, September 2, 1918.

SWANSEA EDUCATION COMMITTEE.

HIGH SCHOOL FOR GIRLS.

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

WANTED, for Christmas next, a SCIENCE MISTRESS.

Applicants must hold an Honours Degree or its equivalent.

Salary scale £150 by £10 annually to £250.

Previous Secondary experience up to five years will be counted in fixing the commencing salary. Application forms may be obtained from the undersigned on receipt of a stamped addressed envelope.

T. J. REES, Director of Education.

Education Offices, 9 Grove Place, Swansea, September 6, 1918.

CITY OF LEEDS TRAINING COLLEGE.

The Leeds Education Committee invite applications for the position of PRINCIPAL for the above Residential Training College.

Particulars of conditions of appointment, with forms of application, may be obtained from the undersigned.

The salary, which will include occupation of house free of rent and rates, will be according to qualifications and experience. It is hoped that the successful candidate will be able to commence duties on January 1, 1919.

Applications, naming salary, in addition to house-rent and rates, should be received not later than October 12, 1918.

JAMES GRAHAM, Director of Education.

Education Department, Leeds, September, 1918.

KHAKI UNIVERSITY OF CANADA.

ENGINEERING TEACHER.

A full-time TEACHER of Mechanical Engineering Subjects is required to conduct Correspondence Courses, and also to give Lectures on Mechanical Engineering Subjects to Canadian Soldiers. Applicants must be good practical men, preferably University-trained, and with teaching experience and exempt from military service. Salary £300 per annum. Applications, accompanied by three testimonials, to be addressed to MAJOR WEIR, 31 Bedford Square, W.C. 1.

UNIVERSITY OF BRISTOL.

The Council invite applications from women, or from men ineligible for military service, for the post of DEMONSTRATOR in PHYSIOLOGY. Salary according to qualifications.

Further information may be obtained from the REGISTRAR.

UNIVERSITY OF LONDON.

ST. BARTHOLOMEW'S HOSPITAL AND COLLEGE.

A DEMONSTRATOR in CHEMISTRY, man or woman, is required for the above Hospital. Salary £200. Particulars of the appointment may be obtained from the DEAN of the Medical School.

Applications should be made not later than September 28, to the DEAN, St. Bartholomew's Hospital, London, E.C. 1.

EAST LONDON COLLEGE

(UNIVERSITY OF LONDON),

MILE END ROAD, E. 1.

JUNIOR DEMONSTRATOR in PHYSICS required. Salary £200 per annum. For particulars apply to REGISTRAR.

HERIOT-WATT COLLEGE, EDINBURGH.

ASSISTANT LECTURER for PHYSICS DEPARTMENT wanted. Salary £150, with extra for Saturday work. Particulars may be had from Head of Department. Applications, and one copy of testimonials, to be sent to Professor STANFIELD, Interim Principal, not later than September 18.

CHEMISTRY TUTOR required to lecture and take charge of laboratory at large teaching Institution in London preparing mainly for London University Examinations. He must be a High Honourman with teaching experience. Commencing salary £240 per annum.—Apply, in first instance, to "CHEMISTRY," c/o U. B. C., 48 Southampton Row, W.C. 1.

Just finishing three years' organising and administration work in high explosives factory; free for other work; eight years' excellent experience in America and Canada; four years on manufacturing side of large soapworks in England; Oxford degree, a first in chemistry; age 38, Grade 2.—Box No. 140, NATURE Office.

ASSISTANT LIBRARIAN required for the LIBRARY of NOBEL'S EXPLOSIVES COMPANY, ARDEER, STEVENSON, AYRSHIRE. Applicants may be either male or female, and must hold a University Degree in Science. Applications, giving full details as to training, age, &c., to be addressed to MANAGER, Research Section, Ardeer, Ayrshire.

RESEARCH CHEMIST, B.Sc. Lond., D.I.C., desires responsible appointment.

Experience as Works Chemist, also in Academic and Technical Research.

Apply Box No. 2550, c/o NATURE Office.

WANTED, OIL CHEMIST experienced in Analysis of Oils, Fats, Waxes, Lubricating Oils, &c. Training in methods of research as applied to oil chemistry a good recommendation. —Reply, stating age, qualifications, &c., to Box No. 138, c/o NATURE Office.

WOMEN SCIENCE GRADUATES required for work in the Metallurgical Laboratory of the Research Department, Woolwich. Salary commences £175 per annum, rising to £200 after six months and £225 after twelve months.—Apply to the SUPERINTENDENT OF RESEARCH, Royal Arsenal, Woolwich.

The WOLVERHAMPTON EDUCATION COMMITTEE require the services of a TEACHER of CHEMISTRY—Theoretical and Practical, Inorganic and Organic (on three evenings and two afternoons per week), at the Science and Technical School. Form of application (which must be returned not later than September 18, 1918) may be obtained on sending a stamped addressed envelope to the SECRETARY, Education Offices, Town Hall, Wolverhampton.

STEWARD WANTED IMMEDIATELY for Chemical Department, Birkbeck College. Ineligible for military service. Wages £2 to £2 15s. per week, according to qualifications and experience.—Apply SECRETARY, Birkbeck College, Breams Buildings, E.C. 4.

For other Official Advertisements see pages x and xi.

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magnetism." In Prof. Birkeland's view, "a nebulous ring round the earth will *alone* never give any satisfactory explanation of the zodiacal light."

THE water supply to the town of Hobart, Tasmania, was the subject of an article in the *Engineer* of September 6. The reservoir has a capacity of 207 million gallons, and the dam is an interesting instance of two gravity wings with an intervening arch section. The wings are 293½ ft. and 203½ ft. long respectively, in straight lengths, and the arch is 232¾ ft. long, with a radius of 200 ft. The wings and the arch are not actually connected; a 6 in. by 6 in. bitumen joint, with sheet-lead faces, forms a watertight key from ground-level to the top of the dam. The maximum depth from the summit of the arch section in the centre to the foundation is 201 ft. The greatest depth of water in the reservoir is 95 ft., and the surface-level is 905 ft. above sea-level. The dam is constructed of concrete, and the arched portion is reinforced with iron rails, both vertically and horizontally. The thickness of the arch at the top is 6 ft., and at the bottom 54 ft. An unforeseen fissure in the foundation necessitated the sinking of a shaft to a depth of 185 ft. below the ground-level; this was refilled with concrete.

L'Aérophile for May gives a description of the Vincent multiplex compass, which, it is claimed, combines in one small case all instruments required by the aviator, the navigator, and the explorer for the determination of magnetic declination and for the solution of astronomical, geodetic, and topographical problems required for determining position and directing the course of travel. It is also claimed that this compass provides a means of steering craft overseas with a precision hitherto unknown. The compass is provided with a reference line or directrix, which may be rotated, a movable index card with sights for the measurement of angles and azimuths, and a style for the solution of time problems. The whole compass is suspended on gimbals inside a box, which is pivoted on a slab. The box carries on one of its faces a needle and a dial, and on its bottom a second needle, which moves over degree graduations on the slab. The method of using the compass is explained.

A FRENCH Electrotechnical Commission has just published, in English and French, the results of an investigation on aluminium. The mechanical and physical tests give the density, coefficient of expansion, breaking stress, and elongation. Chemical analyses were also made. According to the *Revue Générale de l'Electricité* for June 8, the electrical measurements were made at the *Laboratoire central d'Electricité*, and include resistivity and temperature-coefficient of commercial aluminium. A table is given in which the constants for three different samples of aluminium, containing slightly different amounts of impurities, are set out.

DR. P. LINDNER, of Charlottenburg, has taken out a German patent (*Chemiker-Zeitung*, June 29) for obtaining fat from low forms of animal life. By populating suitable waste material with these minute forms he obtains material from which fat may be extracted. As examples he mentions decaying mushrooms and non-edible fungi, putrefying meat, gutter refuse, etc., grass and spoilt hay, masses of dead leaves infested with plant-lice, and stale yeast. Dr. Lindner further states that certain materials may be inoculated with the germs of bacteria or micro-fungi and cultivated. The mass of prepared material is triturated and mixed with water, then heated, and the fat skimmed off; or it may be recovered chemically by treating the triturated mass with a solvent.

WE learn from a note in the Journal of the Society of Chemical Industry for August 15 that the giant kelp of the Pacific Coast is now being utilised on a very large scale for the production of both potash and acetone. The works, which are situated at Potash, near San Diego, California, cover thirty acres of ground and give employment to 1000 men. Acetone, rather than potassium compounds, has become the chief product; it is required for the British authorities, and is of excellent quality. Among the subsidiary products recovered are ethyl propionate and ethyl butyrate, which are now being obtained on a scale never before approached. These compounds serve as solvents, and are especially valuable just now as substitutes for amyl acetate, on account of the necessity for conserving acetates. The quantity of kelp cut last year was about 24,000 tons a month.

THE Cambridge Scientific Instrument Co., Ltd., has issued a new list (No. 137) dealing with the Cambridge microscope lathe-attachment. This is a device recently placed on the market to aid in tool-setting for the production of exact and interchangeable screw-threads. The attachment consists of a compound microscope fitted with an eyepiece that is capable of being focussed on a diaphragm ruled with two fine lines representing the thread-angle of the tool to be used, and with a third line equally inclined to them. When the third line is set parallel to the axis of the cylinder to be threaded, the two intersecting lines represent accurately the position in which the tool must be set. The device is rigidly fixed to the slide-rest, consequently both move together. The standard diaphragm is engraved with a 55° angle. The inaccuracy of tool-setting by this method should not exceed 0° 3′. The list describes also the Cambridge alignment tester for ensuring the correct alignment of machine-tool beds within close limits. In this instrument a microscope fitted with a micrometer eyepiece is used to view a fine wire stretched along the length of the bed. One division of the micrometer scale corresponds with 1/2000″, so that high accuracy is obtainable.

AN outstanding feature of Catalogue No. 175 just issued by Messrs. W. Heffer and Sons, Ltd., Cambridge, is a number of books printed at special presses such as the Kelmscott, Doves, Riccardi, and others. Sections appealing more particularly to readers of a journal such as NATURE are devoted to agriculture, botany, geology, mathematics, physics and chemistry, zoology and biology, physiology, anatomy, and medicine.

THE following works are in the press for publication by the Carnegie Institution of Washington:—"Human Vitality and Efficiency under Prolonged Restricted Diet," by Benedict, Miles, Roth, and Smith; "A Biometric Study of Basal Metabolism in Men, Women, and Children," by J. A. Harris and F. G. Benedict; "Effect of Alcohol on Psychophysiological Functions," by W. R. Miles.

MESSRS. CHARLES GRIFFIN AND CO., LTD., will publish shortly "A Treatise on British Mineral Oil," by E. H. Cunningham Craig, A. G. V. Berry, Dr. A. E. Dunstan, Dr. Mollwo Perkin, and A. Campbell. The work will contain a foreword by Sir Boverton Redwood, Bart., and be edited by J. A. Green.

THE article by Dr. James Ward on "Psychology" in the "Encyclopædia Britannica" has been expanded by the author, and will be published shortly in book form by the Cambridge University Press.

OUR ASTRONOMICAL COLUMN.

THE HARVEST MOON.—The September full moon occurs this year on the 20th at 1.1 p.m. G.M.T., but, although this is so near the autumnal equinox, the daily retardation of the time of rising about full moon is not the smallest possible on account of the unfavourable position of the moon's node. The following are the *Greenwich mean times* of rising, southing, and setting from September 13 to September 28:—

Rises	P.M.	Souths	P.M.	Sets	P.M.
Sept. 13,	1.58	Sept. 13,	5.55	Sept. 13,	9.54
14,	2.46	14,	6.48	14,	10.56
					A.M.
15,	3.25	15,	7.42	16,	0. 6
16,	3.58	16,	8.36	17,	1.23
17,	4.26	17,	9.29	18,	2.44
18,	4.51	18,	10.22	19,	4. 8
19,	5.14	19,	11.16	20,	5.34
			A.M.		
20,	5.37	21,	0.10	21,	7. 1
21,	6. 1	22,	1. 6	22,	8.28
22,	6.30	23,	2. 3	23,	9.53
23,	7. 4	24,	3. 2	24,	11.13
					P.M.
24,	7.46	25,	4. 1	25,	0.23
25,	8.37	26,	5. 0	26,	1.22
26,	9.37	27,	5.56	27,	2. 8
27,	10.43	28,	6.49	28,	2.44
28,	11.52	29,	7.39	29,	3.13

THE NEW STAR IN AQUILA.—A preliminary account of some valuable photographs of the spectrum of Nova Aquilæ obtained during June at the Dominion Observatory, Ottawa, has been given by Dr. W. E. Harper (Journ. Roy. Ast. Soc. Canada, vol. xii., p. 268). The photographs of June 9 are of special importance as showing that the absorption bands which preceded the appearance of bright lines were already strongly displaced to the violet sides of their normal positions, the displacements corresponding with 1250 km. per sec. if interpreted in terms of motion. Emission bands on the red sides of these absorption bands were first recorded, as elsewhere, on June 10. On June 10, 13, 14, and 15 the absorption bands accompanying the bright bands of hydrogen were double, the displacements of the two components representing velocities of 1350 and 2200 km. on June 10, and 1700 and 2300 km. on June 15. From June 17 to June 23 only the less refrangible components of the absorption bands were present, and the velocity indicated was 1750 km. per sec. Sharp H and K lines appeared on all the plates, and these maintained the same positions throughout; their displacements representing a velocity of 22 km. per sec. towards the solar system.

From a circular issued by the Government Astronomer, it appears that the new star was independently detected in New Zealand by Mr. A. G. Crust at G.M.T. June 8d. 21h. 40m., and by Mr. G. V. Hudson at G.M.T. June 8d. 23h. 15m.

The nova is still visible to the naked eye, the magnitude being about 5, with small oscillations. The nebular characteristics of the spectrum are strongly marked.

WOLF'S COMET.—Mr. Jonckheere observed this comet on September 2 with the 28-in. at Greenwich. At midnight it preceded the star BD+22° 3918 by 1m. 33.67s., and was 25.6″ south of it. The magnitude was estimated as 12.8, and the diameter was 30″. Mr. Harold Thomson observed it on August 31 with his 9-in. reflector at Newcastle. He estimated the magnitude as 12, and stated that there was a central condensation of light, but no stellar nucleus. The position agrees closely with Kamensky's ephemeris.

NEW SCIENTIFIC FACTORS IN INDUSTRY.

ONE of the impressions of the British Scientific Products Exhibition that remain in the memory is the silent revolution that many departments of industry have undergone since the war began by processes which could only result from scientific research. Among the processes which have thus been affected, mention may be made of the welding of aluminium, copper, and other non-ferrous metals by oxy-acetylene—branches in which German workers were pre-eminent before the war. Mr. C. R. Darling has shown that continuous research in this direction has resulted in great improvements being effected. "Thermit" processes, formerly under German control, have now passed into British hands, and most of the compositions used are now made in this country, patient investigation having overcome the difficulties involved. A great advance has been made in the art of electric-arc welding, which is now used in the production of "rivetless" ships. This process was in its infancy at the outbreak of war, and at that time was more highly developed in Germany than in other countries. The excellent progress made has been due to the enterprise of the firms which have specialised in this work, and systematic researches are in hand with the view of finding methods for producing the most satisfactory welds at the minimum of cost. Arc-welding is capable of application to non-ferrous metals, and is destined to play an increasingly important part in the future.

The production of high-class steel by the electric furnace has been developed extensively during the past four years. In 1913 the number of electric steel furnaces in Europe and America was 114; to-day there are probably as many in England alone. Mr. Darling suggested that in the event of a large super-power station for the production of cheap electricity being erected near London, it is quite possible that the metropolis may become an important steel-refining centre. The spraying of metals on to cold surfaces by the Schoop process has so far not met with extended application, but it has been suggested that concrete ships might be coated with metal in this manner, so as to prevent the destructive action of sea-water. In the production of materials by the electric furnace, Mr. Darling reminded us that Britain has always been backward, and remains so. Cheap electrical power is needed for the success of this branch of industry, and up to the present these substances have been produced at the hydro-electric installations at Niagara, in Norway, and elsewhere. Calcium carbide is now made in considerable quantities at Manchester, but the cost is far greater than in the case of Norway, owing to the difference in the cost of power. On the other hand, it is now possible to obtain electric power as cheaply on the Tyne as at Niagara, and there appears to be no good reason why carborundum and alundum, now universally used as abrasives, should not be made in this country. The same applies to artificial graphite and other products now extensively manufactured at Niagara.

In the future, furnace products are bound to increase in importance; in particular, refractories urgently needed for electric steel smelting may be expected to be forthcoming, and it is a matter for regret that this branch of high-temperature work has been neglected in Britain. Facilities for research on electric-furnace products on a reasonably large scale are non-existent, and it is urgently important that this defect should be remedied at once. An exception to the general neglect of electric-furnace products mentioned by Mr. Darling is provided by vitreous silica, a material discovered in this country and now forming the basis of a considerable industry, which has attained its present dimensions as the result of continuous research and commercial enterprise. No field of investigation offers greater promise of useful discoveries than that of high temperatures, and vitreous silica may be taken as an example of what might be achieved in many directions if systematic work were carried out.

Dr. Walter Rosenhain, in his lecture at King's College, urged the need for serious attention to aluminium and its alloys. Even now, for aircraft and other military purposes, this subject has the importance of a "key" industry; but considerable development in the wider industrial field may be expected. Dr. Rosenhain claims that, so far as scientific research is concerned, we hold a very high place in regard to light alloys. What is needed now is industrial enterprise which will give commercial application to the results obtained. Cases were mentioned of structural design where the greater efficiency of the lighter material would make it easy, or, at least, possible, to carry out work which could not be contemplated with ordinary steel. Even where there is no approach to a limiting span, there are many cases where the use of a lighter metal would effect very great economy. A direction in which the use of strong and light materials is of very great importance is in the construction of objects which have to be started and stopped. The greatest expenditure of power in many cases occurs in this process of starting and stopping owing to the fact that energy has to be put into the moving objects while they are being set in motion, and has to be absorbed again—and usually wasted—when they have to be stopped. The reciprocating parts of machinery are examples of that kind, and the importance of making these as light as possible has been fully recognised recently. Tube and electric railways generally furnish other impressive examples. To start an electric train and to bring about that rapid acceleration which is the most valuable feature of electric railways, an enormous expenditure of power is necessary. In one actual case the starting current for a train is as high as 3000 amperes at 500 volts. As this same amount of power has to be absorbed when a train is stopped, it is taken up by the brakes and affects the cost of running by heavy wear of rails and tyres. The power required for these operations is simply proportional to the weight of the train. Dr. Rosenhain suggested that if the steel parts of the train, the under-frames of the carriages, and much of the electric locomotives were constructed of light alloy, a very considerable saving of weight would result.

The main reason why light alloys have not come into much wider use is probably due to their cost, which is still very high as compared with that of steel, while there are also certain technical difficulties. Systematic research, however, has now gone far enough to clear the ground and to place aluminium alloys on a secure and sound basis. With regard to cost, although aluminium alloys cannot as yet be regarded as competing with steel, Dr. Rosenhain does not believe that the difference will persist. He looks forward to a cheapening in the cost of aluminium by the development of economical means of separating the aluminium, which is present in considerable proportions in all clays and in many rocks, also in the exploitation and method of utilisation of water-power for this purpose. There lies in this direction a great field for future progress provided that the requisite scientific research and industrial enterprise are applied to it.

Mr. C. H. Wordingham indicated many of the fields in which there was scope for electrical engineering. A new and extraordinary application is to the propulsion of battleships and cruisers, while a most important field has been opened up in connection with salvage work in respect of an electric motor driving a pump which will work wholly immersed in the sea. These and other developments can only take place, however, by a cheap supply of power, and Mr. Wordingham advocated a scheme for the establishment of large or super-power stations. Among the important industries established in this country which are dependent upon the cheap supply of power, Mr. Wordingham mentioned carbons for searchlights and other arc lamps, magnetos, incandescent lamps, and insulating materials. One very important class of insulating materials almost wholly imported from abroad is that known under the generic term of composite materials. These materials are usually mouldable, and are used largely for a great variety of apparatus. One particular class of vulcanised material is a vital part of the magneto used in connection with the ignition and internal-combustion engines.

A curious fact mentioned by Mr. D. T. Chadwick in a paper on the industrial development of India during the war is that, in spite of a forest area of more than 250,000 square miles, imports of timber into India exceed exports by some 250,000 tons a year. These imports consist largely of teak, hard woods, and pine. In some cases wood is imported from Siam when exactly the same was available locally and at a lower price. The development which has taken place since the war is due to the realisation of the vital necessity of utilising local resources, and by the adoption of scientific methods in this process. Inquiries are being carried out in co-operation with business houses in directions in which forest resources are essential to industries. In regard to sandalwood oil, a trade has been established which was formerly centred in Germany; before the war sandalwood to the value of more than 100,000*l.* was exported annually. The factories established in Mysore since the war are now capable of producing nearly 20,000*l.* worth of oil per month of the highest quality, well suited to medicinal purposes. The manufacture of the alloys of iron has been commenced, and, in addition, electric furnaces have been erected at Sakchi, primarily for the manufacture of steel for springs, tools, and other purposes, but it is expected that these furnaces will be devoted to the production of ferro-chrome, ferro-tungsten, and other ferro-alloys. The possibility of developing local resources for aluminium, calcium carbide, cyanide, etc., turns on the supply of cheap electric power from the waterfalls of India.

Many chemical problems associated with industry in India await solution, and one of the activities of the Munitions Board has been to mobilise the chemists and allocate to them specific problems for solution. Hitherto, except in a few cases, chemists in India have been mostly employed in the educational departments scattered throughout the colleges, and have not been in touch with industrial problems. This knowledge and talent is now being utilised. A few of the items of research allotted to different chemists may be cited as indicative of the class of work undertaken; these are colloidal medicinal preparations, the causes which render bleaching powder unstable in hot climates, the proportion of suitable chromate by extraction from chrome-iron ore without the use of caustic soda or sodium carbonate, the refining of waste copper, the refining and preparation of several of the essential oils and varnishes, etc. One of the greatest needs of the immediate future is for more organised practical scientific research into the industrial resources of India, alike in forestry, mineralogy, hydro-electricity, and in the industries themselves. This is the factor which is destined to play a decisive part in the establishment of scientific industry in India.

What has already been achieved in the manufacture of optical glass was explained by Sir Herbert Jackson in his lecture at the exhibition, when the chair was appropriately occupied by Sir William McCormick, administrative chairman of the Department of Scientific and Industrial Research. It is not correct to say that this is a new industry, for during about seventy years the firm of Messrs. Chance Bros. and Co., Ltd., of Birmingham, has been making optical glass of high quality. The progress made during the war has been very great indeed, and there is some sense, perhaps, of humility, along with the feeling of pleasure, that this country has been able to do what it has in the matter of optical glass through the pressure of the war. Apart from optical glass, very great strides have been made in what may be generally described as the scientific glassware industry, and Sir Herbert Jackson predicts that the time is rapidly approaching when we shall meet our entire needs for this type of glassware by home manufacture. For this result credit must be given to the close co-ordination between the Ministry of Munitions, manufacturers, and research workers. Indeed, this industry can well serve as an object-lesson for other industries in respect of the application of scientific research to manufacturing processes. The dependence of the chemical glass industry upon the ready supply of raw materials, which with proper attention can be produced here, is illustrated by the difficulties which have had to be overcome in connection with certain raw materials, notably potash. Investigation has shown that for producing some glasses, and X-ray glass is one of them, there are considerable advantages in the use of potash. When this has not been obtainable in sufficient quantity, much work has been required to produce types of glasses good enough to carry on with containing little or no potash. The position with regard to potash, however, gives no cause for fear that in the future, wherever it is required in glass, it will be forthcoming.

After the war the struggle between the various nations anxious to obtain supplies of essential raw materials will be very keen, and it is necessary, therefore, that attention should be given to the development of home resources. Copper is a metal for which the demand will be exceedingly great. At one time Britain occupied an important place in the list of the world's copper producers. But the British deposits are for the most part small, and many have been exhausted, so that our domestic supplies are almost negligible. On the other hand, as Prof. Henry Louis pointed out in his address, the British Empire contains a number of highly important deposits, some of which, like those of Rhodesia, have not yet reached their full development. The copper resources of other Colonies, notably Canada and Australasia, are by no means unimportant, so that even if the British Empire cannot cover all its requirements of copper from its own resources, it can go a long way towards so doing. Other minerals which abound in this country are in need for their full exploitation, Prof. Louis remarked, of sound scientific education for all engaged in the mineral industry.

Mr. Leon Gaster demonstrated in a lecture that scientific illumination is a necessity. He claimed that the provision of appliances needed for artificial lighting is essentially a key industry, and he was able to illustrate that in the factory good lighting is essential to rapid and efficient work, the prevention of accidents, and the health of operators. Illumination is a factor in industry which has hitherto not met with that appreciation which its importance merits, but the possibility of placing the lighting of factories and workshops on the same level as heating and ventilation under the Factory Acts will appreciably alter the position of illuminating engineering. Instruments have been developed for the measurement of illumination—a process essential to scientific method in lighting problems—and the work has already proved of great value in connection with the war.

ROTHAMSTED IN WAR TIME.

THE report of the Rothamsted Experimental Station for the three years 1915–17 is a striking record of triumph over war-time difficulties and of adaptability to the circumstances and needs of the times. On the outbreak of war the staff of the station was rapidly depleted of two-thirds of its members, whilst the call of various Government Departments for assistance by way of investigation has steadily grown. Largely through the assistance of women the emergency has been successfully met and the more important lines of inquiry have been maintained, although the programme of work is naturally undergoing modifications as new problems arise out of the changing agricultural conditions. At the present time the inquiries fall naturally into four groups: the economical use of manures, the ploughing up of grassland, the control of soil organisms, and the nutrition of plants. With regard to the first-named group of inquiries, the summary given in the report of progress made with investigations of the economy of the manure-heap indicates that along two independent lines of inquiry methods have been developed whereby an actual enrichment of the manure-heap or of straw with nitrogen drawn from the atmosphere may be effected. These methods are at present being tested on the semi-practical scale, and, in view of the very large issues involved, the final report will be awaited with the greatest interest.

In connection with the ploughing up of grassland, the problem of coping with wireworm attack is being dealt with, partly by a study of the natural habits of the wireworm in the soil and partly by way of search for some insecticide or method of treatment which will destroy the wireworm and leave the soil suitable for crops. The interesting question of the weed flora of newly broken old grassland is also receiving attention.

The study of the organisms of the soil, which has been so prominent a feature of the work at Rothamsted in recent years, has been steadily maintained, and substantial progress made in the correlation of the protozoan fauna with bacterial activity.

In addition to the foregoing, an astonishing variety of problems has been dealt with in the period under review, and the long list of papers published and of inquiries undertaken at Government request reveals an activity which only the most efficient organisation and strenuous effort on the part of the staff could maintain.

Not least among the achievements of the war period has been the development of the library from a small collection into an imposing array of some 10,000 volumes dealing with agriculture and the cognate sciences, and including an extremely valuable collection of the earliest works on husbandry. Those who have seen the library in its handsome setting and have had occasion to test the merits of the system of indexing so thoroughly carried out will testify to the debt of gratitude which agricultural research workers owe to Dr. Russell for the great work he has accomplished in building up this library at a time when the normal work of the station must have made the heaviest demands upon his energies.

BACTERIA OF ICE AND SNOW IN ANTARCTICA.

THE researches we were able to prosecute during Sir Douglas Mawson's Australasian Antarctic Expedition (1911–14) in the subject of bacterial flora of snow and ice have given rise to certain queries which, if accurately answered and correlated to the work of four previous observers, should go far towards an elucidation of the bacteriology of Antarctica as a whole.

Dr. Ekelöf,[1] whose investigations for nearly two years of the soil of Snow Hill Island, near Graham Land, were rich in results and of great scientific value, made experimental exposures of Petri plates for possible bacteria in the air. He found positive growths on at least half of his culture media, claiming that a Petri plate had to be exposed for two hours for one bacterium to settle on it. His conclusion is, on the evidence of examinations of soil and on account of the unprecedented weather conditions of his Antarctic station, that the organisms he obtained from the air were impurities carried into it by the wind from the soil.

Dr. Gazert,[2] when frozen in the pack-ice to the north of Kaiser Wilhelm II. Land, sought for bacteria in the atmosphere by making cultures of freshly fallen snow. The cultures were found in every instance to be sterile.

Dr. Pirie,[3] during his voyage in the Weddell Sea, exposed plates and tubes in the crow's-nest (at the top of the mainmast) of the *Scotia*, at the longest for twenty hours, with negative results. During the winter months at Scotia Bay he was unsuccessful in similar experiments, as also during the summer. He records, too, that plates of agar and media (for denitrifying organisms) were exposed on top of the deck-laboratory during the voyage in the Weddell Sea in 1903. He considered the last-named cultures to be unsatisfactory, owing to the possibility of contamination from the ship and from spray. "Growths of (apparently) *Staphylococcus pyogenes albus* and of a yellow coccus, possibly *Staphylococcus pyogenes citreus*, were obtained, and also denitrifying organisms."

With this evidence before us it is instructive to learn that Dr. Atkinson, of Capt. Scott's British Antarctic Expedition (1910–13), apparently made bacteriological examinations of snow.[4] "Atkinson is pretty certain that he has isolated a very motile bacterium in the snow. It is probably air-borne, and, though no bacteria have been found in the air, this may be carried in upper currents and brought down by the snow. If correct, it is an interesting discovery."

Lastly, so far back as 1893, it is the record of Nansen in "Farthest North" that he made frequent microscopic examinations during the second summer of fresh-water pools on the floe-ice of the North Polar basin. Algæ and diatoms were proved to germinate at the bottom of these pools, providing the food material of infusoria and flagellata. Bacteria, he says, were occasionally observed. Again, Nansen noticed that in places the surface of the snow was sprinkled with dust, and he was led, after more extended inquiries, to regard the phenomenon as universal over the North Polar sea. He attributes this fact to floating dust being carried by lofty air-currents from southern lands and then descending to the surface in falling snow.

Doubtless, too, one may infer that equatorial air-currents at a high altitude convey myriads of dust-motes towards the South Pole, where they descend, free or clinging to snow-particles, over the great ice-capped continent of Antarctica. And as evidence towards the probable truth of this speculation we have been able to furnish some isolated observations.

The locus of the main base of the Australasian Antarctic Expedition in Adelie Land was singularly fitted for research of a general character on ice and snow, since here the great inland plateau undulates downwards in *névé*-fields, declining gradually for hundreds of miles, to fall abruptly in glacial slopes to the sea. In fact, we were on the verge of the continent, with no naked mountains or outcropping nunataks[5] encircling us to the south, so far as we were able to judge from sledging journeys into the interior. That is to say, there were in the hinterland no indigenous bacteria of Antarctic soil liable to contaminate the ice and snow, and as an additional safeguard, so to speak, there was a continuous torrent of air always blowing towards the north. The average hourly velocity of the wind during our two years' sojourn in Adelie Land was actually almost fifty miles per hour. The main base with its few rocks was at sea-level, and behind it mounted the glacier back to the vast, upland plain which extends southwards, for the most part at a height of 6000 ft., across the crown of the Pole, itself at an altitude of more than 10,000 ft.

[The results which were obtained from an examination of frozen algæ and frozen seaweed led us to inquire further into the bacterial content of the glacier-ice—apparently as pure as distilled water! And so the organic content of frozen algæ makes a suitable point of departure in considerations of a general character, for in these dirty green lumps of ice are represented practically the whole of the low life which exists and actively multiplies in Antarctica: algæ, diatoms (unicellular algæ), protozoa, rotifera, and bacteria. The algæ (including the diatoms) are universally found, according to the scientific reports of other Antarctic expeditions, as marine or fresh-water types in the ice-girt zone surrounding the continent. In Adelie Land one became accustomed to note in the summer-time that certain of the thawed pools among the rocky ridges were filled with a greenish slime—the filamentous, multicellular algæ.]

On comparing results in Adelie Land and in Australia, it is evident that at least four species of bacteria exist in the frozen algæ:—

(1) Gram-positive cocci, with fine, white colonies, liquefying gelatine very slowly, were almost invariably obtained in cultures.

(2) A gram-positive, sporing bacillus spreading as an abundant, pale, wrinkled, and adherent growth on all media.

(3) Gram-positive, chained, sporing bacilli, occurring as a white, profuse growth on all media. In cover-slip preparations of the ice chained bacilli were always seen.

(4) Short gram-positive bacilli, showing on agar a milky-white growth, which afterwards became yellowish in tint.

The fact of the mere presence of bacterial life in frozen algæ would not seem remarkable along the fringe of the continent, where lichens and mosses thrive during the short periods of warmer weather, and where there is a continuous accession of low life from the sea, the soil, and animals. It is only

1 "Bakteriologische Studien wahrend der Schwedischen Sudpolar-Expedition (1901–3)." (Stockholm, 1908.)

2 Deutsche Sudpolar-Expedition, 1901–3. "Untersuchungen uber Meeresbakterien und ihren Einfluss auf den Sloffwechsel in Meere."

3 "Notes on Antarctic Bacteriology." (Edinburgh, 1912.)

4 "Scott's Last Expedition," vol. i., p. 211. (1913.) We have been unable so far to confer with Dr. Atkinson with reference to his actual results and general conclusions.

5 The Western Party, under Mr. F. H. Bickerton, discovered a small piece of rock on the snow at a height of 3000 ft., 17 miles south-west of the Hut in Adelie Land. This was afterwards identified in Melbourne by Prof. Skeats and Mr. Stillwell as a meteorite.

natural to expect them, and to infer, further, that they migrate for a variable distance into the all-enveloping mass of ice and snow, to all intents and purposes free from organic life.

Again, in morainic ice—macroscopically pure but for particles of soil and grit in small amount—protozoa-like organisms were present, and in several cultures appeared fine, white colonies of gram-positive, staphylococci, together with the gram-positive, sporing bacilli of the white, wrinkled, adherent growth already described.

When our observations had arrived at this juncture there was a clear indication to go further afield in the examination of the ice; at all events, to see the extent of the local bacterial flora. So specimens were procured from various points, free from obvious contamination, on the ascending glacier.

(1) In a magnetic cave, cut shaft-like through the slope of blue ice, about 1100 yards south of the Hut, at an altitude of 300 ft. above the sea, were found in cultures cocci and diplococci, slender bacilli, and a "yeast." Protozoan organisms were also seen.

(2) In cover-slip preparations 200 to 300 yards, 500 yards, and 1000 yards south of the Hut occurred cocci, motile bacilli, yeast-like bodies, and protozoa.

(3) The surface-ice at 1100 yards, altitude 300 ft., yielded in cultures cocci (staphylococci) and short, stout bacilli.

(4) At one mile, altitude 600 ft. to 700 ft., in surface-ice, appeared in cultures gram-positive staphylococci and slender, gram-negative, chained bacilli. Protozoa and yeast-like bodies were demonstrated in the thawed ice-chips.

(5) In the vicinity of Aladdin's Cave, five miles south of the Hut, and at an altitude of 1500 ft., surface-ice showed the presence of protozoa and yeast-like bodies. Gram-positive cocci grew in cultures on several occasions.

Ice at a depth of 4 ft. contained, besides protozoa and yeast-like bodies, gram-positive cocci and gram-negative bacilli, all in smaller numbers than on the surface. Nothing was obtained in a few cultures.

In ice at 7 ft.—from the wall of the cave—cultures were more successful, demonstrating gram-positive cocci and gram-negative bacilli (probably cocco-bacilli). Protozoans and yeast-like bodies were also present.

(6) From the Cathedral Grotto—at eleven miles, and at an altitude of 1800 ft. above the sea—specimens of ice gave in cultures growths of a gram-positive coccus and a gram-negative cocco-bacillus. No protozoa or yeast-like bodies were observed in the preparations from thawed ice.

(7) In a position fifty miles west of the Hut and twenty-five miles inland, nearly 4000 ft. high on the plateau, surface *névé* (a transition between snow and ice) was found to contain cocci and bacilli in their usual numbers, but no protozoa or yeast-like bodies were seen. Many of the bacilli were clumped in zooglœa masses. From four original cultures and several subcultures were isolated gram-positive cocci and gram-negative cocco-bacilli, similar to those grown from other specimens of glacier-ice.

Then, too, we should adduce the evidence of the cultures made in Antarctica and carried back to Australia for examination.

It was to Dr. J. B. Cleland, of the Bureau of Microbiology, Sydney, New South Wales, that we were indebted for a consignment of freshly prepared culture-tubes which arrived by the *Aurora* on her last cruise of relief in the summer of 1913–14. All the tubes reached Adelie Land in good condition, and, to prevent any possible contamination by mould, had been sealed with paraffin.

On a rare calm day early in January, 1914, six agar tubes were taken, with a spirit-lamp and platinum needle, up the slope of the glacier nearly half a mile towards the south-east, where the glacier could not possibly have been soiled by the many sledging-parties which passed up and down during the summer.

There was no opportunity at the time to go further afield. The sun was bright and warm, there was no wind, and the ice was covered with a humid sheen of moisture. The tubes were inoculated from loops of liquid collected with the needle in small cups where thaw-water had accumulated. They were then carried back to the ship and placed in an incubator, which ran at a temperature varying, during blizzards, from about 10° to 15° C.; as a general rule, the temperature was between 18° and 20° C.

Dr. Cleland's report shows that nine cultures of ice were received, that of these, three showed no colonies, and were discarded, and that the remaining six on agar slopes exhibited growth. From three tubes "yeasts" were isolated, two of them giving a pink growth on agar, the remaining one a creamy-yellow growth. Two cultures showed the presence of a gram-positive coccus, producing a fine growth, which died out in subsequent subcultures.

It is a curious fact, and yet a well-known experience, to find that bacteria may live dormant in ice for prolonged periods, and that infection may be carried through ice, but it is not so generally recognised that some bacteria prefer to grow on ice. Micro-organisms, as a rule, are capable of resisting a low temperature when their ordinary activities cease, and they tend, either as single units or in clusters, to throw out a mucilaginous protein substance for their protection. Ravenel, Macfadyen, and Rowland have demonstrated that several bacilli will bear exposure for a few days to the temperature of liquid air (−192° C. to −183° C.). More recently it has been proved that certain bacteria actually survive the temperature of liquid hydrogen (−252° C.), applied for so long a period as ten hours. Bearing in mind such experiments conducted *in vitro*, we could understand that certain organisms carried by dust-motes to the vicinity of the south geographical pole (at an altitude of approximately 10,000 ft.) could retain their vitality in a temperature of −100° C. (−148° F.), if ever the midwinter temperature descends to such a low limit. Certainly, in the prolonged insolation of the summer-time, some hardy organisms on the surface could thaw out, become free, and increase in numbers.

On the other hand, bacteria and their spores have almost a defined limit of resistance to heat—57° C., if applied long enough. Some germs are thermophilic, mainly those which live and multiply in warm-blooded animals; while others—in general terms, the bacteria of the sea, the soil, and the air—prefer the mean temperature of their environment.

In the Antarctic—and the same holds good of the Arctic regions—there is a definite fauna, comprising in the former case the various species of seals, whales, and birds and their parasites, insect-like mites of the mosses, rotifera, and a fairly prolific marine life. The flora of the south is summed up in the lichens, mosses, and algæ, the last-named having a vast distribution amongst the ice encircling and adhering to the continent. Primordial, lowest of all, and standing as an evolutionary basis of the animal and vegetable kingdom are the bacteria, which we may presume to say are universal—clinging to the myriad dust-motes which float from the north; descending in snow on the Antarctic plateau; paralysed for long winter months; active and acclimatised in the liquid thaw of summer; segmenting or sporing in their multiplication; dormant again in the inter-crystalline canaliculi of the *névé* and ice, and free once more to live and increase in the viable reticulum of the glacier. Such a speculative theory may be the key to their cycle of life in Antarctica.

Liquid containing salts in solution does not completely freeze at a temperature of 0° C. (32° F.), and this factor is very important in the maintenance of low and higher forms of Antarctic life. The late Mr. James Murray,[6] of Sir Ernest Shackleton's British Antarctic Expedition (1907–9), has contributed some unique evidence of the habits and powers of resistance to cold exhibited by the rotifers and water-bears.

"To test the degree of cold which they could stand, blocks of ice were cut from the lakes (saline) and exposed to the air in the coldest weather of the whole winter. By boring into the centre of the blocks we found that they were as cold as the air. A temperature of −40° F. did not kill the animals.

"Then they were alternately frozen and thawed weekly for a long period and took no harm. They were dried and frozen, and thawed and moistened, and still they lived. At last they were dried, and the bottle containing them was immersed in boiling water, which was allowed to cool gradually, and still a great number survived. . . .

"Such is the vitality of these little animals that they can endure being taken from ice at a *minus* temperature, thawed, dried, and subjected to a temperature not very far short of boiling-point, all within a few hours (a range of more than 200° F.). . . ."

It would seem that bacteria were the ideal denizens of an environment where, for the greater part of the year, all visible life is banished, and where their minute size, protective changes of form, and versatile reaction to moisture, low temperature, and concentration of salts would be most advantageous for existence. The bacteria caught up in the frozen sea within the liquid sludge of cryohydrates, which circulates between the crystals of fresh-water ice, learn to live, and probably multiply, in a medium of much higher concentration than the ocean to which they are accustomed.

The question now seems naturally to arise: How are we to explain the existence and multiplication of bacteria in ice? And to satisfy such a query we should endeavour to discover what is the ultimate composition of ice, how the crystals of ice are interrelated, and what are the intimate changes which occur in a descending or rising temperature.

We refer to Mr. J. Y. Buchanan,[7] formerly of the *Challenger* Expedition (1874), for the most modern views of ice-formation.

As a result of many exhaustive experiments on the changes which occur in freezing non-saturated saline solutions, he finds that the crystals formed by freezing a saline solution are in their ultimate constitution free from salt. That is to say that "the crystals formed in freezing a non-saturated saline solution are pure ice, and that the salt from which they cannot be freed does belong to the adhering brine." Therefore, we may imagine that when sea-water freezes the primary solidification which takes place is of the fresh-water content, the salts in solution being rejected into the channels which now exist between the pure crystals. As the temperature is still further reduced, accretions of pure ice go to the crystals, and the brine, still further concentrated, remains in the channelled meshwork.

Buchanan makes the whole matter perfectly clear in the following passage, extending his principle to purer forms of ice, such as glacier-ice:—

"All natural waters, including rain-water, contain some foreign, and usually saline, ingredients. If we take chloride of sodium as the type of such ingredients, and suppose a water to contain a quantity of this salt equivalent to one part by weight of chlorine in a million parts of water, then we shall have a solution containing 0·0001 per cent. of chlorine, and it would begin to freeze and to deposit pure ice at a temperature of −0·0001° C.; and it would continue to do so until, say, 999,000 parts of water had been deposited as ice. There would then remain 1000 parts of residual water, which would retain the salt, and would contain, therefore, 0·1 per cent. of chlorine, and would not freeze until the temperature had fallen to −0·1° C. This water would then deposit ice at temperatures becoming progressively lower, until when 900 more parts of ice had been deposited we should have 100 parts residual water, or brine, as it may now be called, containing 1 per cent. of chlorine and remaining liquid at temperatures above −1·0° C. When 90 more parts of ice had been deposited we should have 10 parts of concentrated brine containing 10 per cent. of chlorine, and remaining liquid as low as −13° C. In the case imagined we assume the saline contents to consist of $NaCl$ only, and with further concentration the cryohydrate would no doubt separate out and the mass become really solid. . . ."

In the case of the glacier-ice of Adelie Land, which we wish particularly to consider, one would expect the ice to be very pure; in fact, the superimposed layers formed from the snow which has fallen should be, presumably, as fresh as distilled water. But assuming, as we do, that a large amount of aerial dust is distributed over the South Polar plateau, and that atmospheric gases are combined with the snow, the ice contains mineral constituents, without doubt, in much more dilute solution than is present in the rain-water of a more temperate climate. And, considering that this contamination by dust-motes has gone on for countless æons, the whole thickness of the polar ice-cap is impregnated with minute foreign bodies.

On dissecting a piece of the glacier we find that a disintegration of the interlocking grains, similar to that which occurs in upturned slabs of sea-ice, takes place on its exposure to the warmth of the sun or to a temperature just below the freezing-point of fresh water. As Buchanan says: "Under the influence of the sun's rays the binding material melts first, the continuity of the block is destroyed, the individual grains become loose and rattle if the block be shaken, and finally they fall into a heap. A block of glacier-ice is a geometrical curiosity. It consists of a number of solid bodies of different sizes and of quite irregular shapes, yet they fit into each other as exactly and fill space as completely as could the cubes referred to above."

Buchanan made his studies of ice on the Alpine glaciers, which, in comparison with the ice-sheet of Antarctica, move rapidly, and, of course, are grossly contaminated by soil, rock, and dust. Still, one of the first phenomena we remarked when stepping on to the ice-foot at Cape Denison, Adelie Land, was the large amount of granular rubble which formed the surface of the glacier. In other words, the summer sun had thawed out all the cementing channels, and the crystals lay melting in a clear slush of liquid.

To a living organism a few micro-millimetres in length a block of glacier-ice not completely solidified would be a veritable labyrinth of minute tunnels filled with liquid containing salts in solution. In every direction the tunnels would be viable, so that a single bacterium might easily pass from top to bottom of the block. The same lump, as an integral part of the glacier, would still be perforated with devious and

6 "The Heart of the Antarctic." By Sir E. H. Shackleton, C.V.O. Vol. ii., p. 228. (London, 1909.)
7 "Ice and its Natural History."

circuitous passages, inosculating with others in the surrounding ice, but the watery contents of these passages would follow laws of movement dependent upon gravity, the slope and movement of the glacier, the presence of small seams and cracks in the ice, and the gradient of temperature from above downwards.

Sufficient has been said to indicate that if in the section of ice we are considering the temperature approaches close to freezing-point, the channels of adhering fluid which encircle the crystals would permeate the glacier down to a definite point where, if the mean annual temperature were low enough, the ice would be solid and impervious. We are led to suppose from Buchanan's observations that the critical temperature of solidification may be as low as $-13°$ C., though in Antarctica, where the ice is purer, it should be 4° or 5° higher. Granting that such a temperature may be several degrees from the actual truth, we may at least be sure that for 5° below the freezing-point of fresh water the glacier-ice of Antarctica is pervious to bacteria, and contains a medium suitable for their reproduction.

In Adelie Land the mean annual temperature at sea-level lies between $-15°$ and $-20°$ C., but on mounting the plateau which falls steeply to the coast, the temperature descends at the rate of almost 4° for every 1000 ft. In the summer-time the shade temperature registered on several occasions 5·5° C. (40° F.), and for three months at least the temperature, except for unusual fluctuations due to blizzards, never fell much below $-10°$ C., and was very often close to 0° C. Considering, too, that there is a very appreciable amount of sunshine between the equinoxes, the period during which bacterial life and growth would be possible might be extended, during a favourable summer, up to four months. The action of sunlight is of paramount importance in promoting a thaw throughout the ice canaliculi, especially when we remember that the shade temperature may register 0° C. at the same time as the thermometer in the sun rises to 16° C.

The important point at issue is that the northern slopes of the glacier fall towards the sea at such an angle that the rays of the sun for some months during the summer are normal to the surface, thereby increasing the intra-glacial thaw, and for short periods causing the temperature of the whole mass in the lower latitudes to rise within a few degrees of freezing-point, the optimum temperature of the micro-organisms of ice and snow. At the south geographical pole, elevated to 10,000 ft., the obliquity of the sun's rays and the low temperature would not encourage bacterial life except in the surface layers of snow, and that only for a few weeks at the summer solstice. Assuming that the greater part of the continent is at a more or less uniform height of 6000 ft., we should conclude that the organisms which descend from the air are, when buried to a certain depth, wholly deprived of a free-swimming existence, until in the plenitude of ages they arrive at that northern boundary where the summer thaw begins.

It will be apposite now to review the few observations which were made on snow before passing to a few remarks on the meteorology of the southern hemisphere :—

(1) Gram-positive cocci and gram-negative, sporing bacilli grew in culture from snow of a sastruga or snow-wave one-third of a mile south-east of the Hut.

(2) On three occasions when falling snow was gathered in a sterile basin, elaborate precautions having been taken to prevent contamination, the thawed-out samples showed under a cover-slip cocci, motile bacilli, and, invariably, zooglœa masses of bacteria in moderate numbers. Diplococci, and occasionally cocci, were observed to be invested by a pale capsule. In one case doubtful organic matter in the form of vegetable cells was noted.

(3) A *glucose agar slope* culture of falling snow showed a few small greyish colonies, which were not examined.

Slender as these results are, they become of more importance when correlated with the many positive findings made in glacier-ice—the vast repository of the falling snow. They are meaningless, too, unless we consider the probable origin of the bacteria which cling to the crystals of snow.

Regarded simply, the circulation of air in the southern hemisphere has certain main characteristics—a widespread uprush from equatorial, tropic, and subtropic zones; a continuous flow at a high level towards the southern continent; a subsidence of successive layers of cool air, increasing in density and coincident with a rising barometric pressure; a concentration of air at high barometric pressure over the vast crown of lofty Antarctica; a relief of pressure in the torrential bursts of blizzards through to the low-pressure belt of the Southern Ocean, and, in wide terms, the genesis of a low equatorial return current modified and deviated by such factors as earth-movement, latitude, disposition of island, sea, and continent, and configuration of the land.

Bacteria or their spores may be found in the atmosphere free, incorporated with minute particles of aqueous vapour, or clinging to small foreign bodies. With these foreign bodies or dust-motes we know that they ascend under the impetus of rising equatorial air into the atmosphere to a considerable height, until at length they come under the influence of the great poleward-flowing current. The bacteria meanwhile have cooled, become paralysed, and, either singly or in segregated masses, thrown out their protective capsule of protein material. They travel to the Pole, and here are frozen to spicules of ice or with the dust which has conveyed them are attached to crystalline snow-flakes, sinking lower with the descending strata of air, and alighting at last on the surface of the plateau.

And now, sparse or in numbers, the frozen organisms, extruded with the dust-mote they accompanied to the periphery of the nuclear snow-crystal, commence a new life-history.

When the snow-flakes—on the plateau of Antarctica snow is mostly in the form of sago-like granules—have recently fallen, they lie together in soft, downy, flocculent heaps enclosing, in proportion to the space they occupy, a large volume of air. Under the influence of gravity and the pressure of the wind, and in dependence, too, on the temperature and humidity of the air, the snow becomes denser and more compact, the enclosed air is expelled, and the snow-crystals increase in size. Thus we may conceive that the bacteria tend to be expelled into the interstices between separate crystals, where they await the time when the temperature will rise sufficiently to provide a liquid medium in which their life and species may be renewed. If the temperature still remains too low for liquefaction of the comparatively impure snow adhering around the primary pure crystal, the slow metamorphosis of the snow into *névé* goes on under more or less dry conditions.

In conclusion, if we trace out briefly the subsequent history of these bacteria of ice and snow, we see them in the slow northward surge of the glacier set floating in ice-tongues and bergs of the Antarctic Ocean, where they gradually thaw out and probably become accustomed to the salinity of the sea. They circulate throughout the immense volume of water, clinging to the plankton of the surface, travelling to various depths, reaching, maybe, the ooze in company with sinking foreign bodies. They migrate in the vast, moving ocean currents towards northern lands, where some remain as marine bacteria; others enter the mouths of rivers and become adapted to life in the fresh-water medium they knew in Antarctica, while still others are stranded on the littoral, whence, in a dry condition, they may be transported by wind to a new soil, assuming, perhaps, the characters of anaerobic bacteria. The cycle—centuries or geological periods in duration—begins once more when, in a temperate zone, the descendants, by an endless gamut of fusion or sporulation of the original organisms, rise on dust-motes and rejoin again the bacteria of the upper air, once more liable to enter the current flowing continuously towards the southern pole of the earth.

A. L. McLEAN.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE sum of 500,000*l.* has been given to the University of Chicago by Mr. La Verne Noyes for the purpose of the education of soldiers and sailors and their descendants after the war, and for instruction in American history and the public duties of citizenship.

MAJOR E. W. CALDWELL, who died from burns resulting from experiments with X-rays, has left from two trust funds upon the death of life tenants provision for a foundation in general educational work in Columbia University. His estate is valued at more than 30,000*l.*

DR. E. H. BRADFORD has just retired from the position of dean of the Harvard Medical School. He has been associated with the faculty of the school for thirty-eight years, and an Edward Hickling Bradford fellowship in his honour was recently founded by an anonymous donor of 5000*l.*

ANNOUNCEMENT is made by the South-Western Polytechnic Institute, Chelsea, of courses in science and engineering, analytical and manufacturing chemistry, pharmacy, dispensing, food and drugs, metallurgy, assaying and foundry work, botany, geology, and zoology. For further particulars application should be made to the secretary of the institute.

DR. C. STEPHENSON, of Newcastle-upon-Tyne, has bequeathed the sum of 5000*l.* to the Royal Veterinary College, London, for the foundation of a Clement Stephenson scholarship; 5000*l.* to Armstrong College, Newcastle-upon-Tyne; and 5000*l.* to the Victoria Benevolent Institution, London, to provide assistance for deserving widows and families of veterinary surgeons.

ACCORDING to *Paris Médical*, the French universities have recently acquired for the first time the power of conferring honorary degrees. The recipients are to be foreigners who have done signal service to learning, to France, or to the university. In the case of services relating to any particular faculty, an absolute majority of the faculty and a two-thirds majority of the Senate will be required; in other cases the Senate will have to give its approval at two separate meetings. In all cases Ministerial approval will be required.

IN connection with the department of technical optics of the Imperial College of Science and Technology, South Kensington, lecture courses have been arranged as follows:—"General Optics," by Prof. F. J. Cheshire; "Optical Designing and Computing," "Practical Optical Computing," "Workshop and Testing-room Methods," and "Microscopes and Microscopic Vision," each by Prof. A. E. Conrady; and "The Construction, Theory, and Use of Optical Measuring Instruments," by Mr. L. C. Martin. Inquiries respecting the courses should be addressed to the registrar of the college.

TWO years ago a department of coal-tar colour chemistry was instituted at the Huddersfield Technical College to provide specialised chemical teaching with research facilities for the sudden influx of chemists consequent on the enormous development of the colour industry in Huddersfield. The demand for fully trained chemists is now more insistent than ever, and the recent appointment of Dr. H. H. Hodgson to the headship of the above department is a matter of noteworthy interest. Dr. Hodgson enters his new sphere of activities after nearly three years' successful work as chief chemist for one of the largest firms of chemical manufacturers in the country. Prior to his industrial engagement he was head of the chemical department at the Northern Polytechnic Institute in London. He is the author of numerous original contributions to chemical literature, as well as the translator of five important technological books.

IN the recently published "Handbook of Classes and Lectures for Teachers" full particulars are given of some sixty-two courses of lectures arranged by the London County Council to be given during the school-year 1918–19, primarily for teachers employed in teaching within the administrative County of London. Teachers employed elsewhere will be admitted where accommodation permits, but they will be expected to pay an inclusive fee of 7*s.* in respect of each course instead of merely a registration fee of 1*s.* demanded from London teachers. Among the courses arranged may be mentioned that by distinguished authorities on different branches of science dealing with the application of their science to problems of national life and industry. On October 12 Prof. W. J. Pope will lecture on the national aspects of chemistry; on November 2 Prof. W. W. Watts on geology, with special relation to national life; on November 16 Sir A. D. Hall, K.C.B., on the relation of agriculture to the urban population; on December 7 Dr. H. Eltringham on insect-carriers of disease; on January 25, 1919, Prof. W. E. Dalby on engineering with special reference to its relations with our national life; on February 15 Dr. A. Schuster on pure science in relation to the national life; and on March 8 Prof. J. B. Farmer on some aspects of the rubber-growing industry. The lectures will be given in every case at 11 a.m. at the Regent Street Polytechnic, except Prof. Dalby's, which will be at the City and Guilds Engineering College of the Imperial College of Science and Technology, Exhibition Road, South Kensington, S.W.7. Other courses in science include five lectures in the spring term by Sir Rickman J. Godlee, Bart., K.C.V.O., on surgery past and present; eight lectures, commencing on January 21, 1919, at 5.30 p.m., at King's College, by Prof. W. D. Halliburton, on the principles of dieting, with special reference to reduction of food in war-time; and ten lectures on warfare among the lower animals, by Prof. A. Dendy, commencing on October 4, at 5.30 p.m., at King's College.

THE issues of the *British Medical Journal* and the *Lancet* for August 31 were concerned almost wholly with descriptions of the facilities available in the British Isles for medical education in its different branches. Students are provided in both cases with detailed and clearly stated particulars of how to proceed to graduation in medicine and surgery at the various British universities, as well as how to secure professional qualifications through one of the medical corporations. The *British Medical Journal* points out that between the years 1910 and 1914 the annual entry of first-year medical students averaged roughly 1440. Since the war the number of these entries has increased by five or six hundred a year. Thus the whole number of students actually pursuing medical studies in the medical schools of the United Kingdom has shown a steady upward movement. In May, 1916, the total was 6103; in January, 1917, it was 6682; in October, 1917, it was 7048; while the latest figure, for May, 1918, was 7630. But for some time the large withdrawals of male students from the medical schools for combatant service, or for service as surgeon probationers in the Navy, more than nullified the increased entries, and bade fair to produce a serious deficiency of new practitioners in the years 1918 and 1919. Urgent representations upon this matter were made to the Government. As a result, something has been done to make good the threatened shortage by the return of third-year students from active service to complete their studies, by the retention in the medical schools of students on their way towards qualification who are liable to be called to the colours, and by limiting the period of service of surgeon probationers. The Minister of National Service has further undertaken to provide that, if possible, the supply of students in training shall be kept at a level sufficient to give an annual yield of at least 1000 new practitioners. Another feature of the last four years has been the great increase in the number of women students of medicine. In May last there were 2250 women medical students in the United Kingdom—a figure 23 per cent. greater than the total for January, 1917, and several times larger than in 1914. For this remarkable growth the war must be held mainly responsible.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, August 19.—M. Ed. Perrier in the chair.—J. **Boussinesq**: Rational solution of the two problems of the punching out and flow of plastic blocks, furnished with a rigid, polished ring.—R. de Montessus de **Ballore**: Plane algebraic curves having common multiple points.—P. **Weiss**: The characteristic equation of fluids. The isochores of hydrogen, according to the measurements of Kamerlingh Onnes and Braak, are rectilinear, and give for the law of expansion $v=b+R\frac{T}{p+\Pi}$, where R is the gas constant and Π the internal pressure. For the families of rectilinear isochores studied by the author the relation given by the above equation holds to a degree of precision of the experiments, but R has to be multiplied by a factor greater than 1. Thus it is 1·30 for carbon dioxide. With argon and isopentane the isochores are formed of two straight lines making an angle with each other—that is, the above factor changes abruptly in the case of argon from 1 to 1·39.—C. **Benedicks**: An electro-thermal effect, of which the Thomson effect is a special case.—L. **Gentil**: The neogene deposits of southern Spain.—A. **Sartory**: Sporulation by symbiosis in the lower fungi. Without bacteria being present the perithecium of Aspergillus is not formed. It would appear that under the action of bacteria the medium undergoes a transformation which renders it capable of provoking the production of the perithecium.—H. **Vincent** and G. **Stodel**: The results of antigangrene serotherapy. Details of five cases cured by the use of the serum described in an earlier communication.

BOOKS RECEIVED.

A Calendar of Leading Experiments. By W. S. Franklin and B. Macnutt. Pp. viii+210. (South Bethlehem, Pa.: Franklin, Macnutt, and Charles.) 2.50 dollars.

The Destinies of the Stars. By Dr. S. Arrhenius. Translated by J. E. Fries. Pp. xvii+256. (New York and London: G. P. Putnam's Sons.) 7*s.* 6*d.* net.

Matrices and Determinoids. By Prof. C. E. Cullis. Vol. ii. Pp. xxiv+555. (Cambridge: At the University Press.) 42*s.* net.

Applied Anatomy. By Prof. G. G. Davis. Fifth edition. Pp. x+630. (Philadelphia and London: J. B. Lippincott Co.)

Homeland: A Year of Country Days. By P. W. D. Izzard. Pp. 383. (London: John Richmond.) 7*s.* 6*d.* net.

The Chemistry of Synthetic Drugs. By Dr. P. May. Second edition. Pp. xii+250. (London: Longmans and Co.) 10*s.* 6*d.* net.

Dr. John Radcliffe. By Dr. J. B. Nias. Pp. 147. (Oxford: At the Clarendon Press.) 12*s.* 6*d.* net.

Magnetism and Electricity for Home Study. By H. E. Penrose. Pp. xxiii+515. (London: The Wireless Press, Ltd.) 5*s.* net.

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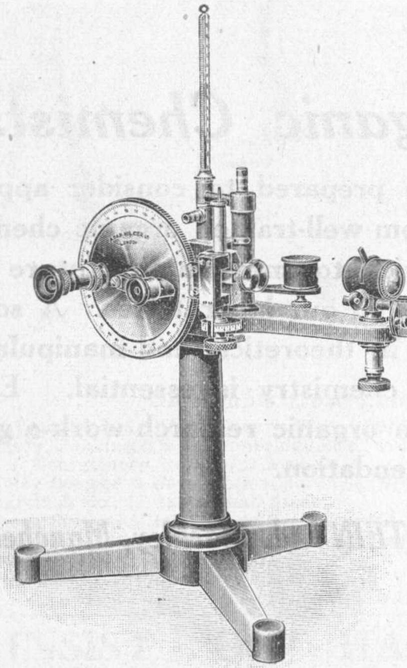

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