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

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INTERNATIONAL ORGANISATION OF SCIENCE.

THE formation of a considerable number of international organisations for the promotion of scientific observation and research is the result of the recognition of the fact that international co-operation is highly desirable in all directions, and is even indispensable in many cases.

A memorandum prepared by the Royal Society early in 1918 gives a list of about seventy-five such associations of scientific workers, and there are many more. The Royal Society list is divided into five groups, which include such subjects as standards of weight and measure, atomic weights and physico-chemical constants, problems in geodesy, seismology, meteorology, and exploration of the sea, the chart of the heavens, an international chart of the world, and the cataloguing of scientific literature. Eighteen congresses which meet periodically are concerned with various departments of pure and applied science, from mathematics to medical radiology, while the International Association of Academies aims at unifying international work and the avoidance of duplication. There are many other associations, some of which have been long in operation, while others have been called into existence by modern developments, as, for instance, in relation to aviation.

Since the beginning of the war it has become increasingly obvious that direct communication between the Allied Powers (including the United States) and the Central European Powers was no longer possible. Neither did it seem probable that the Allies would consent to personal communication with the German peoples, even after the cessation of hostilities, until the latter had adopted an entirely new attitude towards the rest of the world. Of this change of mind and heart there is but small indication at present, and consequently the time when cordial assistance and co-operation can be mutually exchanged between the Allied Powers and the German-speaking peoples seems indefinitely postponed. The problem, then, is, What can be done with these international organisations? They must be freed from German membership and influence, and to accomplish this either the Germans must be excluded or new and independent associations must be formed by the Allies, together with such neutral Powers as, after deliberation, choose to dissociate themselves from Teutonic combinations. The latter appeared to be the only practicable course, and at the conference recently held in Paris, of which an account was given in NATURE of December 26, resolutions were carried affirming the necessity for the formation of new international associations in place of the old. These associations will provide for the development of international action in relation to all the subjects mentioned above, but leaving to diplomatic agency the merely administrative relations between public services, such as those regulating navigation, railways, telegraphs, weather reports, etc.

The representatives of science in the United States propose to go further. An executive order by President Wilson under date May 11, 1918, refers to the National Research Council which was called into existence in 1916 by the U.S.A. National Academy of Sciences, with an eye especially to national requirements in time of war. The work of this council having proved so valuable, it is now constituted on a permanent basis, with duties specified in a series of paragraphs. These duties include not merely the task of bringing into co-operation for national purposes the industrial, naval, and military agencies. The council is expected to stimulate research in every department of science, to survey the larger possibilities of science, to formulate comprehensive projects of research, and to develop effective means of utilising the scientific and technical resources of the country for dealing with these projects. Needless to add, co-operation, national and international, is to be freely invoked.

At the Inter-Allied Conference held in London in October, and at the later Conference in Paris, the idea developed into the proposal not only to form a National Research Council in each country, but the meeting itself assumed provisionally the title of "The International Research Council," with an executive committee of five members and an administrative bureau to be established in London. The president of the new body is M. E. Picard, one of the permanent secretaries of the French Academy of Sciences, the other members being Prof. G. E. Hale, representing the United States; Prof. Volterra, representing the Accademia dei Lincei of Rome; Major Lecointe, representing Belgium; and Prof. Arthur Schuster, representing the Royal Society. It will be the duty of this executive committee to work out the details of the organisation to be ultimately adopted, and to submit its proposals to the various bodies concerned.

Among the subjects discussed at the conference in Paris were the proposals, already under consideration by many universities, for adding to the facilities offered to students of one nationality by teaching institutions in Allied countries. Questions relating to bibliography, the publication of

abstracts of scientific memoirs, and the cataloguing of scientific papers were also considered, as well as the serious international problem relating to patent laws in different countries.

Anyone who has followed the course of events in the scientific world during the last twenty years or more will perceive that subjects of this kind have not been neglected, and that many preparatory steps have been taken, but it is also obvious that in regard to nearly all these matters we have been drifting gradually towards a chaos more and more confounded. The establishment of the system of international councils seems to be the only hope of ultimately arriving at some state of order. Readers of NATURE have been informed of the establishment in this country of the Committee of the Privy Council for Scientific and Industrial Research, and the existence of several subsidiary boards, such as those for fuel research, food investigation, and several others, with related advisory boards, as well as the National Physical Laboratory. But the co-ordination of the whole remains to be accomplished, and, so far as this country is concerned, movement in this direction is not yet in view, though it has long been urged by the British Science Guild and in these columns. The British Government is too fond of leaving things at the disposal of its permanent officials in Whitehall, who, however able they may be as officials, are in nearly all cases laymen in respect to questions involving scientific knowledge and experience. The President of the United States proceeds on a different principle in placing the whole task of organisation in the hands of the National Academy of Sciences, with power to select such representatives of the Government as are required for administrative work.

Perhaps it will be useful to add a few remarks on the subjects which are intended for investigation by these National Research Councils. Broadly speaking, there is no limit; all Nature is to be reviewed, experimented on, sounded, tested. It requires no great foresight to perceive that, on the whole, results which are expected to be immediately useful will especially be looked for by the expectant world outside. Now research may be of two kinds, one of which falls easily within the province of co-operative inquiry: the investigation of the origin, properties, and qualities of natural materials of all kinds—coal and other minerals, fibres, woods, dyes, medicinal agents, and the cultivation of medicinal plants; investigation of problems in connection with agriculture, the strength of metals, corrosion or rusting of metals and decay of all kinds of materials, such as timber, cement, and building-stone. To such inquiries may be added the accurate determination of many physical constants which are at present imperfectly known, such as melting-points, boiling-points, specific heats, or electrical conductivities, all of which may come to be very valuable, or even indispensable, in the improvements to be made in machinery and engines of all kinds.

Here are fields wide enough and full enough to occupy whole armies of workers for generations to come, and they afford examples in every direction where co-operative labour is likely to accomplish that which might defy altogether the unassisted effort of the individual worker. It is also quite possible that in the resulting enlarged and more accurate view of natural materials and resources phenomena will present themselves among which the eye of genius may perceive the way to generalisations of incalculable importance. It was the careful and accurate estimation of the densities of gases by Rayleigh which led to the discovery of the argon series of gases. It was the study of the crystalline form of the tartrates which led Pasteur by successive steps to discoveries which resulted later in the development of the entire department of science known as stereo-chemistry. For ages the fact has been known that certain substances—*e.g.* calcined oyster-shells—exhibit a feeble luminosity; but it was the systematic study of phosphorescent phenomena by Becquerel which led, in the hands of the Curies, to the discovery of radio-activity, with all its amazing consequences.

Similarly, it may be expected that research on a large scale will lead to the observation of phenomena which the international worker may not be able to interpret, but which will remain for study by the exceptionally endowed worker, who, like the poet, invokes the aid of imagination, while at the same time he has the skill, patience, and wide knowledge which enable him to derive assistance from analogous cases in departments other than his own. This kind of specialist is not to be found every day, and will not be developed even by co-operation on international lines. This is the natural genius who appears, like a Newton or a Faraday, once in a century or two. Individual freedom in fields open to research must not be controlled or impeded by schemes of organisation, nor must the public inquire too closely what is the use of this or that discovery. In course of time the study and contemplation of natural phenomena in the light of more extended knowledge will come to be acknowledged as the source of a pure joy and satisfaction to many, as art is a recognised source of happiness to others. This view of the matter should be kept sedulously in mind by every teacher.

HIGH EXPLOSIVES.

High Explosives: A Practical Treatise. By Capt. E. de W. S. Colver. Pp. xxix+830. (London: Crosby Lockwood and Son, 1918.) Price 3 guineas net.

CAPT. COLVER has written this large volume with the object of filling "a marked gap in English technical literature, which is sadly deficient in recent information on the subject of high explosives." Though one may not entirely agree with his statement that there is "very little collected information regarding the manufacture, properties, and use of modern high explosives," there is no such complete account as the author gives in this very comprehensive treatise, especially on the manufacture of these important compounds.

In dealing with this subject the author very naturally directs attention to the present difficulties which must be encountered by a writer owing to the impossibility of publishing certain information, so that it became necessary to restrict the work in many important particulars. Similar restrictions must also apply to criticism of the work for fear of transgression.

In the interesting introductory chapter the old controversy over the use of picric acid as an explosive crops up, and the author's statements are contradictory, for on one page it is stated that its detonating properties were discovered by Turpin in 1885, whilst two pages later Sprengel's address before the Chemical Society in 1873, in which he stated that "it is an extremely powerful explosive provided that it is ignited by a powerful detonator," is quoted. Again, later, Capt. Colver writes that it was Turpin's discovery which had given the explosive industry a particularly valuable new explosive.

The following section deals with raw materials and outlines the separation of the primary products. Although petroleum as raw material is not of great importance, more recent records of production than those for 1911 might have been given. No reference is made to the presence of aromatic hydrocarbons in certain petroleums, although for Russian petroleum "benzene" is twice mentioned as the first distillate, when it should obviously have been "benzine" (the specific gravity being 0·725).

In dealing with synthetic phenol, a raw material that has been made on a large scale, only one process of manufacture is referred to, the benzene-sulphonic acid method.

Very complete chapters deal with the nitro-compounds of the aromatic hydrocarbons and of the phenols and naphthols. Trinitrobenzene is stated to be the most suitable of the highly nitrated aromatic hydrocarbons for use as a detonating explosive, the proportion of oxygen giving it advantage over trinitrotoluene, as also does the maximum density attainable, 1·67 as against 1·62 for the toluene derivative. Although slightly more sensitive than T.N.T., it is less so than picric acid. Trinitrobenzene is not at present extensively used, probably owing to the difficulty and expense of manufacture. Attempts to nitrate T.N.T. more highly are shown to result in the formation of trinitrobenzoic acid, or even rupture of the benzene ring with the formation of tetranitromethane, the intense odour of which has been perceptible where decompositions have occurred during manufacture.

Less extensively employed nitro-derivatives, including hexanitrodiphenylamine and the polynitroanilines, and others which have scarcely reached the stage of practical application, are described. Tetranitroaniline is stated to have proved by practical tests the most powerful of all the explosives hitherto used. Several explosives of this class have been employed for aircraft bombs; thus mixtures of two parts of T.N.T. with one part of tetranitroaniline, or of hexanitrodiphenylamine (dipicrylamine), are stated to have been used by the Germans.

Search for suitable raw materials outside the pure chemical compounds has naturally engaged attention, principally in the directions of utilising tar products boiling over a wide range, and petroleum hydrocarbons. Naturally the nitro-products are complex in character; thus from coal-tar naphthas mixtures of solid and liquid nitro-products are obtainable, those from fractions boiling above 200° C. containing many nitro-derivatives of the naphthalene series. The nitro-products from petroleums are stated to consist generally of uncrystallisable masses of reddish-brown colour suitable only for certain plastic explosives. The possibility of obtaining generally useful materials by direct nitration does not appear promising. A sounder procedure would appear to lie in "cracking" the oils for the production of aromatic hydrocarbons which can be separated and then nitrated.

Indirectly prepared nitro-derivatives of paraffin hydro-carbons are of considerable interest, and the author considers that here is a profitable field of research. The remarkable substance tetranitromethane $[C(NO_2)_4]$ has been patented as an oxidiser for other organic compounds, as in the Sprengel type of explosives. This compound is comparatively non-volatile, has no acid properties, is completely stable, insoluble in water, and not affected by it. Hexanitroethane $[C_2(NO_2)_6]$ forms colourless crystals, which are extremely insensitive to percussion and friction.

Considerable space is given to the German rules and regulations governing the manufacture, etc., of explosives, the author considering that the ripe experience of the Germans justifies this. British regulations are not dealt with. There is a useful section on the toxic effect of raw materials and products. Some contradiction is evident over the relative liability of more or less highly nitrated products to produce ill-effects, for the general statement is made that the toxic effect of the lower grades of T.N.T. is greater than that of the pure substance, whilst in a previous passage the statement occurs that in general with the various nitrobenzenes (and nitrotoluenes), "as the

number of the nitro-groups increase, the compounds have a proportionally greater toxicity."

A useful section deals with the manipulation and working up of the finished explosives, grinding, mixing, the filling of shells by plain casting, casting under pressure to increase the density of the charge, and by pressing the solid charge.

The later chapters are devoted to questions on the use of explosives, the measurement of pressures, energy, etc.; then follows an appendix containing a comprehensive review of patents (which is supplemented later by a "Patents Register"). A short further appendix deals with specifications. This last section is extremely meagre, but possibly restrictions were placed on the author in respect to British specifications, and moreover those handling the materials have to be familiar with the requirements.

The volume is inconveniently large; much space might have been saved with advantage. For example, graphic formulæ are unnecessarily large; in one instance three formulæ almost fill one page; subdivision into separate chapters where collection under one heading was possible has led to much blank space, and some very simple diagrams have a whole page devoted to each.

IS PSYCHOLOGY ONE OF THE NATURAL SCIENCES?

Psychological Principles. By Dr. James Ward. (The Cambridge Psychological Library.) Pp. xiv+478. (Cambridge: At the University Press, 1918.) Price 21*s.* net.

PSYCHOLOGY, ever held in high honour as a philosophical science, is to-day claiming to be one of the natural sciences. Sometimes it is distinguished as the new psychology. It regards its subject-matter as amenable to treatment in laboratories, and in two directions, one educational and industrial, the other medical and therapeutic, it appears to have established its claim to be assigned a special realm of scientifically classified facts.

Since 1884, the year in which Dr. Ward wrote the famous "Encyclopædia Britannica" article, the output of this new psychology in books and journals and society proceedings has been enormous, its variety almost defying classification. It ranges from statistics and correlations to elaborate hypotheses of the fundamental nature of the reality of psychical phenomena. Throughout this whole period Dr. Ward's "Encyclopædia" article has stood almost unchallenged in its authority as the exposition of the principles which must govern every science of the soul. There are only two books which can compare with it in this respect—namely, James's "Principles of Psychology" and Stout's "Manual," and these are in no sense rivals, for each of the three is unique. Yet we cannot help sympathising with Dr. Ward's disappointed feeling that the conditions necessarily attaching to an article in an encyclopædia are a serious handicap to its usefulness compared with the unrestricted form of the separate treatise. At last, however, we are allowed to have this important work in a volume, and the wonderful thing is that it appears, not as an overdue promise in the fulfilment of which we have lost interest, but as a new work with all the freshness of youth; and the large additions to the original article are not makeshift appendages, but natural developments.

No one who reads this book can fail to appreciate the significant service Dr. Ward has rendered to psychology. It is evident alike in the paths he follows and in those which he avoids as sidetracks, or turns away from as false routes. We are not invited, for example, to begin with a more or less detailed description of the nervous system, and we are therefore spared altogether that illusion which so powerfully influences the psychologists whom it fascinates, the illusion that it is only a little gap in our science, an unfortunate hiatus we have not yet succeeded in bridging, which prevents us passing directly from physiology to psychology, from the science of the nervous system to the science of the mind. Again, with a clear conception of its utter futility, Dr. Ward rejects the notion that psychical facts belong to the same order of reality as physical facts, differing from them only in their diaphaneity and elusiveness, but capable of being mathematically treated by cunningly devised psycho-physical apparatus. Dr. Ward's attitude towards such method is shown in a characteristic note in the preface, in which, apologising for the retention of the chapter on "Memorising, Rhythmising, and Reading," originally inserted "by way of illustrating the so-called new psychology," he adds: "If there is one chapter more than another in the book which may be 'skipped,' it is this."

The greatness of this book is not in its negations, but in the clear and masterly way in which it sets forth the principles that govern psychology. No development of the science, or possible discovery, can affect these. First and foremost is the principle of the unity of the subject of experience with his experience. This is fundamental in Dr. Ward's view, and insisted on in striking arguments and clear expressions. The point of view of psychology is individualistic. Psychology is the science of individual experience. As presented to an individual, "the whole choir of heaven and furniture of earth" may belong to psychology.

In close connection with this definition of the subject-matter and scope of psychology is the principle of the indissolubility of the subject-object relation in experience, and the inseparability of its factors into subjects of experience on one hand, and objects of experience on the other. The subject-object relation is not a dualism of two terms, but a duality in unity. The importance of this principle in regard to the status of psychology as a science can be easily seen. In the physical sciences we select among the objects of experience special groups and classes and treat them on the assumption that they are in their essence what they are known to

be, that they are independent of the knower, and that they interact among themselves according to laws of nature. The whole success of physical science depends upon the justification in experience of this assumption. We cannot delimit the subject-matter of psychology in any such way. Subjects of experience are not a class of objects, and do not interact with objects in the way we assume that objects interact with one another. Psychology, therefore, is not one of the sciences in the sense that it possesses its own section or has its own department of the general stuff of reality. It deals with the whole of reality, but in a particular aspect and from a particular point of view.

The other fundamental principle on which Dr. Ward insists is closely allied to this, but still far from receiving general recognition. In psychology we are studying the activity of monads. The essence of this concept is that every subject of experience mirrors the whole universe from an individual point of view. There is no common universe which all subjects of experience share; the interaction of monads must be explained by a different scheme from that which serves us in physical science.

One-third of this book (chaps. xii.–xviii.) is new matter which had no place in the original "Encyclopædia" article. It is not new to those who have followed the vigorous development of Dr. Ward's thought in his Gifford lectures and occasional articles, and especially in the striking Henry Sidgwick lecture on "Heredity and Memory" (1913). It is no small compensation for the years during which we have had to resort to a reference library in order to study Dr. Ward's views that we have now in a single complete volume the gathered fruit of his life-work in its maturity. 1050 H. WILDON CARR.

ORGANIC AND APPLIED CHEMISTRY.

(1) *The Chemistry of Synthetic Drugs.* By Dr. Percy May. Second edition, revised and enlarged. Pp. xii + 250. (London: Longmans, Green, and Co., 1918.) Price 10*s.* 6*d.* net.

(2) *Organic Chemistry for Advanced Students.* By Prof. Julius B. Cohen. Second edition. Part i., "Reactions," pp. viii + 366; part ii., "Structure," pp. vii + 435; part iii., "Synthesis," pp. vii + 378. (London: Edward Arnold, 1918.) Price 54*s.* net.

IT is a healthy indication of the increased interest which is being taken in applied chemistry that so much of the literature published at the present time deals with questions connected with the future development of chemical industry in this country. It is, of course, well known that at the outset of the war we experienced considerable difficulty in maintaining the supply of many of the synthetic drugs which up to that time had been procured almost entirely from Germany, and, but for the voluntary work done in many of the educational laboratories, there would have been no supplies whatever of some of the most valuable local anæsthetics.

(1) The publication of the second edition of Dr. May's well-known book is, therefore, to be welcomed in the hope that it may help to attract workers to a branch of chemistry which has not hitherto received in this country the attention which it merits. The text of the new edition does not differ materially from that of its predecessor, but we note that the chapter on "Organic Antiseptics" now contains a short account of Ehrlich's work on the trypanocidal dyes trypan blue and trypan red, as well as a mention of the flavines and their use in the treatment of wound infections. The inclusion of the chloramines in chap. xii. is also a new feature, and the section on salvarsan and its related compounds has been extended and brought up to date.

The book contains much useful and interesting information, and will no doubt continue to be freely consulted by those engaged in the manufacture of synthetic drugs.

(2) The publication of the second edition of Prof. Cohen's well-known book, however, serves as a timely reminder that no real progress can be made without a scientific foundation, and that the future of chemical industry is dependent upon the supply of scientifically trained chemists who must be conversant with the fundamental principles underlying the modern developments of their science. Since the publication of the first edition of this book in 1907 it has undoubtedly played a very important *rôle* in the training of students of chemistry in this country, and has been freely consulted both by students and by their teachers. The present edition has altered somewhat in outward form, consisting as it does of three volumes instead of two. The three volumes are devoted to "Reactions," "Structure," and "Synthesis" respectively, and by this arrangement it has been found possible to group together allied subjects and link them, so far as possible, in a consecutive form.

Considerable additions have been made to the subject-matter throughout the book; thus, for example, a useful chapter on "Abnormal Reactions" has been added to Part i., while in Part ii. the chapter on "Isomerism and Stereoisomerism" has been considerably improved by the inclusion of an account of recent work on the Walden inversion. The most important additions, however, have been made in Part iii., which deals with "Synthesis"; here we find considerably more space given to the carbohydrates for the discussion of the structure of glucose, the glucosides, and disaccharoses, as well as the chemistry of fermentation. The chapter on "Proteins" now contains a section on "Chlorophyll," but, curiously enough, no mention is made in the list of references to Willstätter and Stoll's book on this subject. The chapter on "Alkaloids" has been brought up to date by the inclusion of an account of Perkin's work on cryptopin and protopin, as well as a reference to Robinson's recent synthesis of tropinone. Considerable additions have also been made to the chapter on "Terpenes and Camphors." The new edition will be welcomed by all serious students of organic chemistry, and its success is assured.

OUR BOOKSHELF.

Studies in Primitive Looms. By H. Ling Roth. Part iv. (Bankfield Museum.) (Halifax: F. King and Sons.) Four parts, price 3*s.* each.

MR. LING ROTH has now completed his important technological monograph, of which four parts have recently appeared in the Journal of the Royal Anthropological Institute. In the introduction to the series he remarks that "weaving is generally considered to be the outcome of basketry and matmaking, and in most cases probably it is so." The arrangement of the monograph is geographical, and Mr. Ling Roth discusses the interesting problem of the origin of these varied types. Some, he thinks, were invented on the spot, and do not owe their origin to copying or to contact with other races. But this is not always the case. The African varieties—fixed heddle, pit treadle, and horizontal narrow-band—are all probably of Asiatic origin, the last having undergone so many modifications that, compared with its prototype, it is almost unrecognisable. The warp-weighted loom was used in ancient Greece, in the Swiss lake dwellings, and at the beginning of the Bronze age. It appears in Scandinavian saga in the eleventh century, and was probably in use by the Northern peoples many hundred years before that time. Mr. Ling Roth has illustrated his monograph with excellent sketches, drawn from all available sources, and his technical knowledge has helped him in discussing the various types. It may be hoped that he will extend his collection of papers, and republish them in a more accessible form.

Alfred Russel Wallace: The Story of a Great Discoverer. By L. T. Hogben. (Pioneers of Progress: Men of Science.) Pp. 64. (London: Society for Promoting Christian Knowledge, 1918.) Price 2*s.* net.

THE name of Alfred Russel Wallace is rightly held in honour as that of one who with few advantages of birth or education made for himself a distinguished position as naturalist and traveller, and who, besides adding largely to the acquaintance of scientific men with certain regions previously little known, and making extensive collections of their fauna, achieved independently the discovery of natural selection, the most illuminating principle ever enunciated in the history of biological study. It is obvious that the life of such a man cannot be treated adequately in a small book of sixty-four pages, and Mr. Hogben's volume does not pretend to be more than a sketch. In view, however, of his necessary limits, it is to be regretted that the author has not observed a better proportion in the selection of facts to be recorded. Details of Wallace's early life are interesting in their bearing on his later development, but we could have spared the account of the arrangement of desks and fireplaces in the grammar school at Hertford if Mr. Hogben had given us in its place a few more particulars of the exploration of the Amazon and of the Malayan islands. On the subject of geographical distribution the tone of the book is scarcely fair; and on p. 47, besides some careless punctuation, there is a distinct error of fact. With such amiable weaknesses as anti-vaccination and spiritualism we are not concerned, but we greatly miss a more extended account of the work that really made Wallace's reputation. F. A. D.

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.]*

Fuel Economisers.

I CAN corroborate Mr. R. C. Parsons's remarks in NATURE of December 26 with regard to the advantages of economisers connected with stoves, as I have had them in use for the last twenty-six years with very satisfactory results, the heating being better with a greatly reduced consumption of fuel. My economisers differ from those of Mr. Parsons only in being arranged symmetrically behind the stove, and not to one side of it; and in having an opening in the dividing partition in the box, which is usually closed by a damper, but can be opened so as to provide a direct passage for the gases from the stove to the chimney, so giving a better draught to the fire when it is being lit. During these years I have had two stoves and economisers in use here; one is a Gurney slow-combustion stove, which has an economiser of about the same heating area as itself. This stove goes day and night during the cold season. The other is a common cylindrical slow-combustion stove, and its economiser has got about twice the heating area of the stove, and is only occasionally used.

When the Gurney stove was first fitted in, it had no economiser, and the result was unsatisfactory. All the hot air went to the top floor, and the ground floor was but little benefited, as it received only the radiated heat. After the economiser was added conditions were entirely changed; all the ground floor was now much better warmed. The reason for the change is evident when we consider what takes place under the two conditions. With the stove alone a good fire had to be kept up, and the highly heated air ascended to the highest part in the house, and tended to remain there, where it lost its heat to the ceiling, which is the coldest part of a top room; but when the economiser was added there was double the heating surface, so a much larger amount of air was heated, though not to so high a temperature. The hot air did not now have the same tendency to keep near the ceiling and lose its heat there, and the larger volume of hot air put into circulation enabled all the air in the ground floor to be heated.

These things are better understood in Switzerland, and in other countries where fuel is dear, than is the case here. There one frequently sees stoves built of bricks and tiled, 4 ft. or 5 ft. in diameter, and from 6 ft. to 8 ft. high, with a small wood fire burning in the centre of them.

With regard to the common cylindrical stove above referred to, another advantage of the economiser is that after the fire is lit it at once begins to warm the room, whereas the outside of the stove takes an hour or two to heat through the fire-brick lining, while the economiser is heated and begins to warm the room almost at once.

If coke is used in the stoves there is no trouble with soot in the economisers, such as was found here with economisers used in connection with ordinary coal-stoked room fires. The stove economisers here require to be cleaned only once a year, principally for dust.

When the Government undertook the control of coal, plans and descriptions of the above economisers were sent to the Controller of Coal Mines.

JOHN AITKEN.

Ardenlea, Falkirk, December 27, 1918.

University Poverty or Parsimony?

SHORTLY before the war broke out there was some correspondence, in NATURE and elsewhere, with reference to the pay offered to chemists in advertisements of the Research Department of Woolwich Arsenal. Exception was taken to the offer of little more than 100*l*. a year to men who were supposed to have received training rendering them competent to undertake research work. As a result, I believe, the Department was led to attach a rate of pay to the posts not quite so inadequate as that first proposed.

Apparently during the war some slight conception of the value of chemistry to the nation has been forced upon the public. So much has been said about the importance of research that we are almost as willing as the Americans to "talk big" about it, and put emphasis upon the first syllable. We even recognise (on paper) an indissoluble connection between science and industry; in fact, so great is our advance that several literary men have been appointed, at high salaries, to supervise the expenditure of public funds on technical scientific inquiries. It is true the Board of Trade has systematically declined to associate science with the dyestuff industry, but only by way of being the exception to prove the rule. The Board, we know, is a superior body, and not to be led by any vulgar policy; the highest explosives would not cause its august officials to accept advice.

The President of the Board of Education, too, has often discoursed eloquently on the value of intelligence; moreover, the need of attracting intelligence, if not genius, into the chemical and other learned careers is a topic we never weary of airing in these days.

My object now is to direct attention to the way in which the learned are living up to their own professions, to urge that charity really should begin at home. I do this because my eye has casually fallen upon an advertisement in your columns in which applications are invited by the Vice-Chancellor of the University of London for a University chair of chemistry tenable at King's College at the princely salary of 600*l*. a year. Thus do we testify to our belief in ourselves. No man can fulfil the duties of such a chair adequately on such pay.

It can only be supposed that the University desires to write down the value of King's College chemistry in comparison with that taught at the South Kensington and University Colleges. A more effective way could not well be found, and in the interest of the subject it would undoubtedly be better to concentrate the teaching at two schools.

If, however, chemistry be retained in existence in the Strand, and funds be not forthcoming for the proper endowment of a chair, at most a lectureship should be established; and it would be wise to provide that candidates should not exceed about twenty-five years of age and should hold the appointment at most during ten years.

Let us hope that the profession will make no response to the invitation. Unless chemists themselves take some effective action to protect their interests, the position of chemical science in this country will not only be worse than it was before the war, but must steadily degenerate as years go on.

HENRY E. ARMSTRONG.

Inter-Allied Conference on International Organisations in Science.

IN the account of the Inter-Allied Scientific Conference at Paris published in NATURE of December 26, reference ought, perhaps, to have been made to the status which it has been decided to give to the self-governing British Dominions. These will be able to join any international association under the proposed scheme, on signifying their intention to do so, with the same voting power as independent States.

ARTHUR SCHUSTER.

Yeldall, Twyford, Berks, December 27, 1918.

SCIENTIFIC RESEARCH AND PREVENTIVE MEDICINE.

IT was stated recently in these columns that the toll of pain and death due to causes which are more or less preventable may be gauged in terms comparable with those demanded by the sufferings directly attributable to war. In order to reduce such sources of national loss it was considered important that in the evolution of schemes for the furtherance of research work in pure and applied science the question of the encouragement of research work in all branches of medical science should occupy a prominent place. The pandemic of influenza recently experienced may be taken as an illustration of the need for wide-embracing and well-organised research work in preventive medicine, and particularly in epidemiology. That such an epidemic would well deserve thorough and extensive investigation seems self-evident. According to the medical correspondent to the *Times* of December 18 and 19, 1918, there is good reason to estimate the world's death-roll from influenza and pneumonia at not fewer than 6,000,000 lives, at which rate he points out that this epidemic has been five times as deadly as the war during the same period of three months. Now a visitation on such a scale as this, in which many of the victims are in the prime of their lives, is comparable with the great plagues of the Middle Ages, and, coming at such a time as the present, is catastrophic from whatever point of view it may be regarded.

Epidemics of influenza have recurred at intervals for some hundreds of years, and in recent times have fallen on us in 1803, 1833, 1837-38, 1847-48, and 1889, when it became annual for several years. From 1860 to 1889 the disease became practically extinct, the mortality per 1000 being about 0·003. Even during these epidemics the case mortality was low when compared with that which has obtained in the present outbreak, and was estimated at 1 to 1·6 per 1000. One of the most remarkable features of the recent epidemic is the tendency to the development of very acute toxic symptoms with such astounding rapidity that the body of the victim is overcome by the poison before defences can be put up; in any case, the defence is of a very temporary

nature, so that there is always the possibility of further attacks overwhelming the enfeebled commonwealth of cells, if exposed to reinfection. It is possible that in earlier epidemics the causal relationship between influenza and fatal lung and heart failure was less clear than it is in the recent one, and might have been overlooked, although the coincidence between outbreaks of toxic pneumonia and influenza has long been known. In some respects circumstances are now very favourable to the spread of such infectious disorders: overwork is a common condition; our national dietary, cleverly controlled though it be, cannot be regarded as a normal one, since freedom of choice is limited; overcrowding is in many areas inevitable, and doctors are few.

As is the case with other contagious diseases which have shown a tendency to increase of late years (diphtheria, for example), the fundamental causes of the epidemic are unknown, and are to be discovered only by widely organised co-operative investigation. It is not even certain that we are dealing with the same organism as is responsible for the causation of so-called "influenza" during non-epidemic times: if it is the same, then the causation of the sudden increase in virulence remains to be explained; if not, then we are confronted with the problem as to the origin of the germ, or as to its lurking-place in the interim between epidemics, or as to the causes of the subsidence of the prevalence of its effects. It is known that passage through hosts belonging to a different species may either augment or diminish the virulence of bacteria to man, and the relation of influenza to the somewhat similar affection of cats and dogs and to the condition known as "pink-eye" in horses is perhaps worth definitely clearing up. The tendency to recurrence, and especially to the recurrence of a particular variety of this polymorphic disease in the same locality, has led to the view that the germ possibly lurks in the soil, or, as suggested by a correspondent to the *Times Engineering Supplement* of December 19, in drains.

The mode of spread of influenza along lines of traffic suggests that the disease is communicated by personal contact, and the success which has attended the wearing of gauze masks as a means of protection not only indicates the usual method by which infection is incurred, but also shows what can be accomplished by the adoption of simple measures of safeguard. The condition is known to be extraordinarily infectious, even in the early stages, and there can be no doubt that it is often widely, though unwittingly, spread by those with slight attacks determined to "carry on"; anyone so doing not only lays himself open to the possibility of fatal complications, but may also infect a large number of others in the meantime, and the fact that his own attack was a mild one is no security that the disease transmitted to others will be of a similar degree of severity. We are not even certain that the disease may not be spread by "carriers" themselves in apparent health, although this does not seem likely.

The Medical Research Committee has already collected a good deal of information with regard to this epidemic, and it is sincerely to be hoped that a means will be found by some such organised body of workers for preventing its further spread or repetition. Researches into this subject will be valuable, not merely as contributions to bacteriology, but also as useful material for the study of epidemiology in general.

What applies to influenza applies with equal force to other infectious diseases; in all cases there is a pronounced liability to leave chronic organic diseases as after-effects. Although medical attention is necessarily attracted to these chronic states, it seems obvious that proper attention to their fundamental causation would not only be more worthy of the name of research, but also lead to results of permanent value in connection with public health. For example, regular and systematic examination of the heart by means of the electro-cardiograph and other appliances for the exact investigation of the heart in all cases of infectious disease would probably throw light on one of the underlying causes of disablement by chronic heart disease. The same is true of the investigation of the activity of the kidney on the lines of experimental physiology and experimental clinical medicine. The medical correspondent to the *Times* of December 24 has rightly directed attention to the fact that the influenza epidemic, "with its 6,000,000 deaths and its incalculable disablement, is the price of public indifference to health affairs"; research into epidemics, he states, must begin in the fever hospitals and in general practice, where the cases are to be met. Such research must necessarily be organised, and its results integrated after careful sifting by some centralised body of experts. The records of properly conducted investigation into malaria, kala azar, syphilis, diphtheria, tetanus, trench fever, typhoid, and sleeping sickness have led to valuable results, although much more remains to be done. Who has heard of extensive research work on measles, scarlet fever, or whooping cough in recent years; yet who doubts that these diseases may leave many and serious after-effects which often need very prolonged treatment in after-life, and incontestably produce extensive disablement? The most stultifying of all attitudes is that which leads medical practitioners to "treat symptoms as they arise." More attention should certainly be focussed on the causation of these symptoms, and in the infectious diseases we have very prolific sources of chronic disease.

WIND CIRCULATION OF THE GLOBE.

UNTIL some twenty years ago meteorology was regarded as an elementary science founded on theories so simple that they might be taken as self-evident. Thus the cyclone was looked upon as a warm column of rising air with spirally inflowing winds at its base; the anticyclone, conversely, contained a cold core of de-

scending air. Now we know that the opposite is in reality the truth; the cyclone has a cold core, the anticyclone a warm one. Another theory of equal simplicity and perhaps of even greater antiquity explained the general circulation of winds around the globe. It was argued that solar heating made the equator very much warmer than the poles; therefore there must be a rising current at the equator, a poleward flow of air in the upper layers of the atmosphere, a descending current in polar regions, and an equatorial flow in the lower layers. To question the validity of such a theory would have been regarded as almost an impertinence.

In a recent paper[1] Hildebrandsson has dealt in a comprehensive manner with this question of world circulation, avoiding preconceived theories, but collecting all available information on the subject. Incidentally he puts forward several very cogent reasons why the simple theory outlined above is untenable, though there can be few meteorologists of the present day who regard it at all seriously. The main surface currents have for a long time been fairly well known, and it is with the upper winds of the troposphere that the greater part of this paper is concerned. The chief sources of information are (1) cloud observations from the international network of stations which observe cloud motion, and (2) results of pilot-balloon and *ballon-sonde* ascents. The former afford the larger body of data, while the latter present more detailed information and provide valuable confirmation of the general conclusions otherwise arrived at.

The main general system of world currents is made up as follows:—(1) Over the thermal equator there is a current from east to west at all heights, weak near the surface of the earth, but very strong in the upper layers of the atmosphere. (2) In the temperate zones the currents are from west to east. In the lower layers of the atmosphere the intermediate regions between these two current systems contain the tropical anticyclones and the trades, which blow from N.E. in the northern hemisphere, and from S.E. in the southern. In the upper layers the easterly wind over the equator veers in the northern hemisphere successively to S.E., S., and S.W. as one passes northward, thus turning into the well-known counter-trades. These feed the upper part of the tropical anticyclone from the equatorial side, while the polar side is similarly fed by a deviation of the main westerly current to N.W.

The above form the chief wind systems of equatorial and temperate latitudes. In arctic and antarctic regions data are more scanty, and the wind currents do not seem to fall into any such simple system in these parts of the globe. It is interesting to learn that the great monsoon currents, which have such an important influence on the meteorology of many regions of the earth, are relatively shallow, being not more than 4 km. to 5 km. in depth. They must be regarded only as great perturbations in the general system of circulation outlined above. Similarly, the cyclones and anticyclones of temperate regions are phenomena of the lower layers, above which blow in general the undisturbed westerlies at great heights.

A valuable feature of the paper is the numerous tables, which set out the data obtained from different parts of the globe. Mention must also be made of two charts showing the upper wind currents which prevail above the North Atlantic "High" in summer and winter. It is unfortunate that practically no velocities are given, wind directions only being dealt with. The reasons for this are fairly obvious in the case of cloud data, but it would have added to the value of the discussion if in the tabulated pilot-balloon observations wind velocity had been given as well as direction. Throughout the paper directions are indicated by degrees from one of the cardinal points, but no uniform plan seems to be followed. There appears little justification for denoting a direction as N. 70° W. in one place, and W. 20° N. in another, to quote one example. It is desirable to point out that the references on pp. 12–17 to the plates at the end of the paper are mostly in error. These detail imperfections do not, however, appreciably detract from the great value of the paper as a comprehensive study of world air currents.

J. S. D.

[1] "Résultats des Recherches Empiriques sur les Mouvements Généraux de l'Atmosphère," Nova Acta Regiæ Societatis Scientiarum Upsaliensis, ser. 4, vol. v., No. 1. Pp. 50+plates. (Upsala, 1918.)

THE VISIT OF PRESIDENT WILSON.

THE visit of Mr. Wilson to Europe, and to England especially, is an event of the highest moment, not merely because it is the first time that a President of the United States has left the shores of his great and powerful country, but also because he has come upon a mission of grave consequence—so grave, indeed, that he has deliberately set aside all precedent—to the civilisation of the world, and to help in the settlement of the public affairs of a continent plunged into a welter of confusion unparalleled in the history of man. He comes, though a participator, and in large measure a determining factor, in the victorious issue of the colossal efforts made to meet the imposing onslaught on men's liberties on the part of a great autocracy backed by all the immense resources of modern science, with a message of reconciliation and goodwill to the nations concerned in the dreadful struggle of the last four and a half years. We are all now confronted with the arduous duty of laying the foundations of a new polity which shall assure the means, through long years of tribulation it may be, of a progressive, contented life in harmony with the well-being of humanity. Mr. Wilson comes armed with the spirit of right and justice; he will maintain the one and demand the other, and he trusts to the essential power of these two great principles to ensure the conditions of a firm, just, and lasting peace. He has shown himself, from the time he led his nation into the

struggle, to be a man of high courage, with a real grasp of affairs, and of unwavering loyalty to high ideals and to the truth; and his visit here has been hailed with delight by all men of goodwill.

The State banquet given by the King and Queen at Buckingham Palace on Friday, December 27, in honour of the President and Mrs. Wilson marked an occasion of high significance, not only to the two nations united by it, but also to all free peoples. It was the historic expression of a union formed in a common cause and strengthened by the common purpose of establishing peace and freedom among the communities of the world. "You come," said the King to the President, in proposing the health of the principal guests, "as the official head and spokesman of a mighty Commonwealth, bound to us by the closest ties. Its people speak the tongue of Shakespeare and Milton. Our literature is yours, as yours is also ours, and the men of letters in both countries have joined in maintaining its incomparable glories." In President Wilson the scholar is combined with the statesman, and knowledge is associated with the courage of conviction. He has crossed the Atlantic to promote the spirit of brotherhood in the hearts of men, and "to make the right and the justice to which great nations like our own have devoted themselves the predominant and controlling force of the world." When these ideals are realised, a new epoch in the history of mankind will begin; they were advanced by the exchange of pledges at Friday's banquet and by the hope expressed by the King that the brotherly spirit which brought the response to the call of humanity would "inspire and guide our united efforts to secure for the world the blessings of an ordered freedom and an enduring peace."

It is gratifying to notice that, in addition to members of the Government and other statesmen, the distinguished guests at the banquet included leading representatives of science, as well as of art and literature, among those present being Sir J. J. Thomson (president, Royal Society), Major-Gen. Sir George Makins (president, Royal College of Surgeons), and Dr. Norman Moore (president, Royal College of Physicians).

NOTES.

THE list of New Year honours includes the following names of men known in scientific circles:—*Baronet:* Sir Lewis Amherst Selby-Bigge. *Knights:* Dr. W. Leslie Mackenzie, medical member of the Local Government Board for Scotland; Dr. G. D. Thane, principal inspector under Cruelty to Animals Act, Home Office; Dr. Prafulla Chandra Rây, Indian Educational Service, Bengal; and Col. Sir Almroth E. Wright, Army Medical Service. *K.C.V.O.:* Sir George Anderson Critchett, surgeon oculist to the King. *C.S.I.:* Dr. H. H. Hayden, director of the Geological Survey of India. *C.B.:* Mr. C. E. Ashford, headmaster, Royal Naval College, Dartmouth; Mr. P. W. L. Ashley, assistant secretary (Department of Industries and Manufactures), Board of Trade; and Dr. R. B. Low, assistant medical officer, Local Government Board. *C.M.G.:* Mr. Frank Tate, Director of Education, Victoria. *C.I.E.:* Lt.-Col. J. T. Calvert, principal, Medical College, Calcutta; Dr. W. Crooke; Mr. C. G. Roberts, Chief Conservator of Forests, Burma; Mr. T. R. D. Bell, Chief Conservator of Forests, Bombay; Mr. W. F. Perree, Conservator of Forests, Kumaon, United Provinces; Mr. B. B. Osmaston, president, Forest Research Institute and College, Dehra Dun; and Prof. J. C. Lamont, professor of anatomy, Medical College, Lahore, Punjab.

AT the annual meeting of the English Forestry Association held on December 18, Major G. L. Courthope, the president, gave some interesting details on the timber requirements of the Government and the available supplies existing in the country. The position is sufficiently serious to require earnest attention. The Timber Supply Department, the president said, was anxious to close down as soon as possible, but the Government looked to it to ensure the supplies which would be required during 1919. The demand alone next year, irrespective of commercial and trade demands, was expected to amount to 100,000 standards a month. There was nothing approaching that quantity in this country. The Department had rather more than a year's supply on the stump, calculated on the basis of the existing rate of output. The Controller of Timber Supplies had informed them that the shipping position was getting easier, but it would be some time before anything like adequate supplies of imported timber could be expected. There was a world shortage, and the countries which had supplies of converted material were holding them up for better prices. The foreign forestry workers (Portuguese, Finns, etc.) were being demobilised, and the demobilisation of the Canadian Forestry Corps was soon to take place. In their stead 16,000 demobilised British soldiers would be employed. It was certain that this country would require from 300,000 to 350,000 standards for reconstruction purposes during the next twelve months. In the United Kingdom there were something like 4½ million standards remaining standing. We imported 3,000,000 standards in 1913 alone. Lord Selborne said that if British landowners had not been far-sighted and public-spirited enough for generations past to carry on their plantings, in the absence of any public encouragement of any kind, this country would have been far more handicapped in carrying on the war than had been the case. The existence of the woods in Great Britain had saved the shipping situation on one hand and the coal situation on the other.

WE regret to learn, from the *Journal des Observateurs*, that M. Luizet, assistant at the Lyons Observatory, died on November 20, 1918. M. Luizet's special field was the observation of variable stars, and he prepared reports on this subject which have appeared from time to time in the *Journal*.

WE regret to notice the death on December 23, as the result of an accident, of Dr. Leonard G. Guthrie, distinguished by his work in nervous diseases and the history of medicine. Dr. Guthrie delivered the Fitzpatrick lectures at the Royal College of Physicians in 1907-8, and as secretary and vice-president of the section of medical history at the Royal Society of Medicine he did much to further that branch of research. He was president of the Harveian Society of London in 1913-14.

THE first lecture of the second series arranged by the Industrial Reconstruction Council will be held in the Saddlers' Hall, Cheapside, E.C.2, on Wednesday, January 8. The chair will be taken at 4.30 by the

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Marquess of Crewe, K.G., and a lecture entitled "Industrial Unity" will be delivered by the Right Hon. G. H. Roberts, M.P., Minister of Labour. Applications for tickets should be made to the Secretary, I.R.C., 2 and 4 Tudor Street, E.C.4.

AT the general meeting of the Scottish Meteorological Society, held on December 19, the following officers and other members of council were elected for the ensuing twelve months:—*President:* Dr. C. G. Knott. *Vice-Presidents:* Prof. T. Hudson Beare and Mr. J. Mackay Bernard. *Council:* Mr. D. A. Stevenson, Mr. R. Cross, Mr. S. B. Hog, Mr. G. Thomson, Dr. A. Crichton Mitchell, Mr. G. A. Mitchell, Mr. M. M'Callum Fairgrieve, Prof. R. A. Sampson, and Capt. T. Bedford Franklin. *Hon. Secretary:* Capt. E. M. Wedderburn. *Hon. Treasurer:* Mr. W. B. Wilson.

IN *Helvetica Chimica Acta*, No. 4, appears an obituary notice of Prof. R. Nietzki, who for many years occupied the chair of chemistry at the University of Bâle, and had become noted for his work on the chemistry of certain groups of dyestuffs. Prof. Nietzki was born in 1847, and studied pharmacy in his early career. Later he became an assistant to A. W. Hofmann, and in 1876 held a similar position at Leyden, where he began the researches on colouring matters to which much of his life was afterwards devoted. He discovered nitranilic acid, and worked out the methods of preparing quinone and hydroquinone which are still employed for making these articles. In 1879 Prof. Nietzki accepted the post of research chemist with a firm at Biebrich, and signalised his appointment by the discovery of the dyestuff known as "Biebrich Scarlet," of which notable quantities are produced at the present time. He went to Bâle in 1884, and in association with his students continued his researches until ill-health brought about his retirement in 1911. The notice of his death, which occurred in September, 1917, is contributed by Prof. Noelting, who includes in it an important summary of Prof. Nietzki's investigations on aniline black, the quinones, azo-derivatives, safranines, oxazines, thiazines, and other groups of organic compounds.

DR. CHARLES R. VAN HISE, long connected with the United States Geological Survey, died on November 19 last, aged sixty-one years. His work, aided by the liberal system of Government publication at Washington, may be truly described as monumental. In 1883 he was called on to examine the iron-ore region of Lake Superior, under R. D. Irving, and five years later this work came under his control. His important summary of the grouping of the iron-ores appeared in 1897 (21st Ann. Rep., U.S. Geol. Survey, part 3), accompanied by a monograph on "The Marquette Iron-bearing District," in which W. S. Bayley co-operated. This monograph, No. 28, contains descriptions and an admirable series of coloured illustrations of siliceous banded iron-ores, which are of fundamental importance for comparison with similar rocks throughout the world. Dr. Van Hise extended the petrography of this subject in 1911 in his monograph (No. 52) on "The Geology of the Lake Superior Region," in collaboration with C. K. Leith. We owe to this work the experimental investigation of Leith's "greenalite," a marine silicate distinct from glauconite, and a close consideration of how far the magnetite in the bedded ore-deposits is a product of reduction from iron carbonate or greenalite, or how far it may be ascribed to transference from intrusive basic rocks. Meanwhile, Dr. Van Hise had issued his great "Treatise on Metamorphism" (Mon. 47, 1904), in which he reviewed all the changes undergone by rocks since their first stage of deposition or consolidation. Such varied subjects as the disintegrating action of white ants, the decomposition of silicates, and the flow of rocks under pressure, come within the range of this comprehensive work. Pre-Cambrian formations naturally attracted much of Dr. Van Hise's attention; but his range of reading was wide, and his duties as president of the University of Wisconsin brought his experience as an administrator into a high educational field.

WE regret to announce the death of Mr. J. P. Johnson at Johannesburg from pneumonia, following an attack of influenza, at the early age of thirty-eight. Mr. Johnson was born in London in 1880, and was educated at Dulwich College and the Royal School of Mines. In 1902 considerations of health compelled him to emigrate to the Transvaal. On the outbreak of the war he was living in Tasmania, where he intended to settle, but returned to South Africa, where he died on October 18, 1918. At an early age Mr. Johnson was an enthusiastic student of the Pleistocene deposits of England and of stone implements, and several papers were contributed by him to the Proceedings of the Geologists' Association, the *Geological Magazine*, the *Essex Naturalist*, and *Science Gossip*. He was a born hunter, and made many important additions to the Pleistocene faunas of West Wittering and Ilford and the Eocene fauna of Walton-on-the-Naze. In South Africa he found an almost virgin field, and the results of his work were embodied in "The Stone Implements of South Africa" (1907, second edition 1908), "Geological and Archæological Notes on Orangia" (1910), "The Prehistoric Period in South Africa" (1910; second edition 1912), and numerous papers published by the Geological Society of South Africa, the South African Association, the British Association, and in the columns of NATURE. Mr. Johnson was a member of the council of the Geological Society of South Africa, and was appointed by the South African Government a member of the Commission to report on the petroglyphs and rock-paintings of South Africa, many of which are reproduced in "The Prehistoric Period in South Africa" (second edition). He was also a keen student of the ethnography of South Africa, and his conclusions are embodied in the same work, of which a third edition was in hand at the time of his death. In his profession as a mining expert Mr. Johnson was greatly respected, and his services were urgently sought for by prospecting syndicates, whilst his works on "The Mineral Industry of Rhodesia" and "The Ore Deposits of South Africa" are standard books.

THE party of American technical journalists recently on a visit to this country as guests of the Government was entertained by the Master and Wardens of the Worshipful Company of Stationers on December 18, together with a gathering of British colleagues. The meeting had been arranged by the Institute of Journalists' Circle of Scientific, Technical, and Trade Journalists, and, in spite of the unavoidably short notice arising from some uncertainty regarding the return of the American party after its tour in France, a considerable number of editors of technical papers in London were present. After tea and a reception a meeting was held, at which Mr. H. C. Parmelee, Mr. S. O. Dunn, Mr. H. Cole Estep, Mr. H. M. Swetland, and Mr. A. J. Baldwin delivered short addresses on behalf of the American technical journalists, while Mr. L. Pendred, Prof. R. A. Gregory, and Mr. A. C. Meyjes responded for the British technical Press. It was very pleasant to note, in the addresses of our friends from the United States, that they were entirely at one with us in their appreciation of the importance of the duties which the technical Press can perform. Some

striking instances of the services rendered in connection with the war and their influence on the industrial development were given, and stress was laid on the value of wide and thorough training, with the view of raising the status of technical journalism as a profession. A resolution was moved by Mr. H. C. Parmelee, seconded by Mr. A. C. Meyjes, and carried unanimously, urging the desirability of closer co-operation and periodical exchange of views between the trade and technical Press in the two countries. Mr. L. Gaster, chairman of the circle, who presided, voiced the pleasure of the meeting in welcoming the guests, and Mr. A. J. Baldwin expressed the hope that British technical journalists would reciprocate by sending a deputation to the United States in the near future.

IN the *Scientific Monthly* for November (vol. vii., No. 5) Dr. Philip A. Means describes the social conditions of the Piura-Tumbes region of northern Peru. The population is divided on ethnic lines into three groups: pure Indians, pure whites, and mestizos (*i.e.* those of mixed ancestry). The landowners are, for the most part, of the white races; the Indians are engaged either in agriculture for the landowners or on the coast in fishing; while the mestizo class is occupied in shop-keeping, hotel-keeping, and kindred employments. In spite, however, of the excellent climate and the abundance of fruits and vegetables, the condition of most of the people is far from idyllic; their houses are often wretched huts indescribably dirty, while their personal habits are so unclean as to encourage disease. The author makes a plea for a benevolent paternalism in government, aiming at building up a wholesome, sane, and virile peasantry. The people have a peculiar aptitude for hand-weaving, which, if rightly encouraged, might both make the region world-famous for woven fabrics and help to develop the inhabitants. Excellent cotton and wool are already produced there, and with proper scientific study silk and flax could be grown in large quantities. Dr. Means suggests that the genius of the people for hand-weaving should not be suppressed by the introduction of mechanical methods, but encouraged, and in time, with the right sort of loom, the inhabitants would quickly show the world new kinds of cloth by new combinations of material. Tile-making he would also encourage. Other interesting suggestions for the development of this region are put forward in the article—suggestions which are pertinent to regions other than that of Piura-Tumbes.

THE rapid increase and spread of the great crested grebe in Warwickshire forms the subject of a short paper by the late Mr. Geoffrey Leigh in *British Birds* for December. On the majority of pools already in use the number of breeding pairs is increasing yearly, whilst fresh sheets of water are being constantly occupied. The author expresses the opinion that this species is, as a rule, double-brooded. This increase apparently dates from about the year 1900, and it is to be hoped that it will receive no check.

IN the *Irish Naturalist* for November–December Mr. R. F. Scharff expresses the opinion that the red deer found in Ireland to-day are the descendants of the indigenous stock of the island, and casts doubt on the trustworthiness of the statement that red deer were imported into Ireland during the thirteenth century from England. There can be no room for doubt that in prehistoric times the red deer roamed in great numbers all over the island, and the author holds that it is unlikely that in the thirteenth century this native race would have been so reduced as to need reinforcement.

THAT the Zoological Society of London has come through a time of severe stress and anxiety with remarkable success there can be no question, even though, as announced at the monthly general meeting held on December 1, there has been a great falling off in admissions to the gardens during 1918 as compared with the corresponding period for 1917. There has also been a similar decrease in the number of fellows elected and re-elected. We may, however, anticipate a steady and lasting improvement now that the disturbing factors are disappearing. The most important addition to the gardens during December was a Kea parrot (*Nestor notabilis*).

MANY years ago it was pointed out by Prof. Bryan in *Science Gossip* that the pollen-grains of certain plants exhibit marked "black-cross" effects in polarised light. The Journal of the Royal Microscopical Society for September last contains an abstract of a paper by Mr. F. J. Keeley in the Proceedings of the Academy of Natural Sciences of Philadelphia dealing with polariscopic effects produced by certain diatoms. These effects, which were previously discussed by Mr. E. M. Nelson, are probably attributable to internal reflections, an explanation which may, perhaps, apply equally well to the pollen. The existence of these effects in *Actinocyclus ralfsii* has led to Mr. Keeley observing an exceedingly delicate secondary structure in this optically remarkable diatom.

THE preservation of game-birds in its relation to agriculture has for some time past become a subject of political controversy, and it is therefore gratifying to find the subject treated in a scientific spirit by Dr. Walter E. Collinge, of St. Andrews, in *Science Progress* for October last. Dr. Collinge has conducted an extensive series of examinations of the contents of the crops of the three principal game-birds, namely, the pheasant, red grouse, and partridge. The proportions of animal matter are 37·4, 22·5, and 40·5 per cent. respectively, this consisting mainly of injurious insects, with very small percentages of worms, slugs, and non-injurious insects. Of the vegetable matter the percentages of grain are 2·4, 1·5, and 3·5, the great bulk being described as "leaves, stems, and seeds of weeds." In view of the benefits which these game-birds are capable of conferring upon agriculture, Dr. Collinge contends that, apart from all other considerations, their preservation is a question of urgent national importance. On the other hand, he advocates the systematic destruction of other species of birds, such as the house-sparrow, rook, and starling, which are costing the country millions of money in the food products destroyed.

IN the Kew Bulletin, No. 7, a further instalment of "Notes on the Flora of Madras" is published by Mr. J. S. Gamble, the author of the flora now in course of publication. These notes deal with the natural families and genera which form part ii. of the flora, "Celastraceæ to Leguminosæ—Papilionatæ," which has recently been published. Among plants of unexpected occurrence in Madras may be mentioned *Leea aequata*, which is found in Bengal and Burma, and *Turpinia nepalensis* (Staphyleaceæ), a Himalayan mountain species found in the Madras mountains. Mr. Gamble proposes six species of the difficult genus Nothopegia; one of these, *N. dalzelli*, was originally described by Dalzell in 1849 as a new genus, Glycycarpus, and about three of the others there has been considerable confusion, now admirably settled by Mr. Gamble's careful researches. In the same issue he describes ten new species of South Indian Rosaceæ, Myrtaceæ, and Melastomaceæ.

THIS year, 1919, which is the centenary of the founding of the settlement of Singapore by Sir Stamford Raffles, marks also the sixtieth anniversary of the establishment of the Botanic Gardens. In the year 1859, on November 12, the Singapore Agri-Horticultural Society was formed, and received the support of the Governor, Col. O. Cavanagh, who afterwards became chairman of the committee of management. Within six weeks of the formation of the society some fifty-six acres of abandoned Government land were granted, as well as convict labour for setting in hand the cultivation of the garden site. The history of the establishment of the gardens is given in the Gardens Bulletin, Straits Settlements, vol. ii., No. 2, with a map showing the area granted to the Agri-Horticultural Society in 1859, and the further grant of land in 1866. The site is still occupied by the Botanic Gardens. Originally the society hoped to benefit local agriculture, but as its first object it set about preparing a pleasure garden for public resort. Between the years 1870–74 the society appears to have lost interest in the gardens, and have got into difficulties, so much so that in 1874 it offered to hand over the gardens to the Government. This was done in December, 1874, and the advice of Sir Joseph Hooker, then director of the Royal Gardens, Kew, was sought as to a superintendent. In October, 1875, the new superintendent, James Murton, selected by Hooker arrived in Singapore with a large supply of plants, and carried on the able work done by Lawrence Niven, the first superintendent, to whom the general lay-out of the gardens is due. From Murton's day to the present time the Singapore Botanic Gardens have become renowned as the centre of Great Britain's botanical activity in the Far East.

THE September issue of the *Scientific Australian* gives the results of the tests of New South Wales timber made by Prof. Warren, of the University of Sydney, for the Defence Department of the Commonwealth Government. The three timbers tested gave the following mean values for the modulus of rupture in lb. per square inch:—Ironbark, 29,000; blue gum and spotted gum, each 22,000. These values compare favourably with those found in the United States Government tests of American hickory, of which seven varieties gave mean values of from 12,000 to 19,000, while each variety showed a wide range of quality. It seems desirable that the great strength of these New South Wales timbers should be known to engineers in this country.

SAWDUST, chips, and shavings are largely utilised in Germany for the production of alcohol. It is estimated that from half a million to one million tons of such waste material are produced annually in that country. Four distilleries are at present being run on these raw materials, each having fifty-one autoclaves of 1000-kg. capacity. The cost of production is said to be high when the residue cannot be used as cattle fodder or the waste liquors used for other products. The material is heated in an autoclave with either sulphurous or hydrochloric acid for from twenty to forty minutes at 265° C. at a pressure of 7 atm., then quickly drawn off, neutralised, and run into the fermenting vat, beer-yeast being used. Distillation completes the process. Further particulars are given in *Zeitschrift für angewandte Chemie* for September 13 last.

IN *Elektrotechnik und Maschinenbau* for September 1 are given the results of some investigations by Gumlich on the magnetic properties and resistance of iron alloys. The samples consisted of pure electrolytic iron and four series of alloys with increasing carbon content (up to 1·8 per cent.). The density and specific resistance vary with the percentage of added material. The tests also showed that the magnetic properties of iron are not improved appreciably by the addition of silicon and aluminium. The benefit derived by the presence of these materials is only due to secondary causes by virtue of the removal of oxygen and neutralisation of the effect of carbon. Eddy-current losses are reduced by the addition of silicon and aluminium. The effect of the added materials on the coercive force is also examined. Good permanent magnets may be produced by adding tungsten, chromium, or molybdenum.

THE second number of the *Decimal Educator*, a quarterly publication of the Decimal Association, contains extracts from several articles by prominent writers in favour of the metric system of weights and measures, including the article by "A. F. B." which appeared in NATURE for August 30, 1917. In connection with the misapprehension which is often to be found in industrial circles regarding the difficulties and expense that would be involved in the compulsory adoption of the metric system, it is pointed out that the proposals of the advocates of the system do not include any obligation to use metric measures in manufacturing operations, but only in commercial transactions. Many useful hints for lecturers on the metric system are to be found in the article on teaching the system, which is continued in this issue. The undesirability of over-elaborating the difference between the values of corresponding metric and imperial denominations is insisted upon, and it is shown that in most cases there are simple approximate relations which will suffice for all practical purposes. An account is given of the present stage of the proposal for introducing decimal coinage, and from correspondence which appears in this issue it would seem that the movement is receiving considerable support throughout the country.

WE have received a letter from Dr. G. C. Simpson, meteorologist to the Government of India, on the subject of aurora at low heights in the atmosphere, supplementary to one from him which appeared in NATURE of September 12 last (p. 24). Dr. Simpson now informs us that the Scott Antarctic Expedition of 1911–12, of which he was a member, had with it "a complete equipment for determining auroral heights by Prof. Störmer's photographic method, but, unfortunately, the experiments made were unsuccessful." In some comments on Dr. Simpson's previous letter Dr. Chree expressed the hope that the observers of the next Arctic or Antarctic expedition would be familiar with what had been written on the subject, and be specially careful in dealing with any apparently low-level aurora. Dr. Simpson is apprehensive lest this should be supposed to imply censure on the observers of the Scott expedition. We can assure him that no reflection whatever was intended on the observers of *any* previous expedition. The subject, as Dr. Simpson's letter alone would suffice to show, is beset with pitfalls for the unwary, and it is important that *future* observers should realise adequately the completeness of the evidence necessary to establish the existence of aurora at really low levels. Dr. Simpson's own writings on the subject form part of the literature the study of which we should like to recommend.

THE *Engineer* of December 20 reviews the project known as the Georgian Bay Canal, which will probably be undertaken by the Canadian Government at an early date, now that the war has ceased to impose a veto on civil engineering enterprise. The design of the waterway in question is to link up the arm of Lake Huron, called Georgian Bay, with the St Lawrence River at Montreal. It will undoubtedly

prove a great convenience for water-borne grain traffic, which at present is conveyed from Fort William and Fort Arthur on Lake Superior to Montreal *via* Lakes Huron, Erie, and Ontario. The new route, embracing a total distance of 440 miles from the entrance at the mouth of French River to the city of Montreal, will constitute a saving of 282 miles. There are naturally 346 miles of navigable lake and river and 66 miles of channel, in which the requisite depth can be obtained by dredging, leaving 28 miles only of canal to be constructed. There is a rise of 98 ft. between Georgian Bay and the summit level at Trout Lake, which will be surmounted by four locks from 21 ft. to 29 ft. in lift. Succeeding this there is a fall of 659 ft. to the St. Lawrence River, necessitating twenty-three locks from 5 ft. to 50 ft. in range. The intention is to provide a waterway 22 ft. deep, to accommodate lake boats 600 ft. long, 60 ft. beam, and 20 ft. draught. The estimated outlay is 100,000,000 dollars, and the work of construction will probably take ten years to complete. The canal project will materially alter the regimen of the Ottawa River, which forms the major portion of the route. At present it is a series of deep and wide basins, connected by narrow passages, which are broken by falls and heavy rapids. For the purpose of lockage, the falls are to be concentrated and all the small rapids eliminated. The forty-five dams required for the regulation of navigation (eighteen are of considerable size) will serve to concentrate the water-power at certain points, and it is computed that nearly a million horse-power will thereby become available, though possibly not more than 150,000 h.p. at minimum flow could be developed under existing conditions.

THE "Wellcome Photographic Exposure Record and Diary" for 1919 is issued by Messrs. Burroughs Wellcome and Co. as usual. Those who are in the habit of using this pocket-book will probably be surprised to find that the exposure calculator is improved, so that when set it shows the exposure required for all the ordinary apertures of lenses instead of one only, and that this is facilitated by printing the figures in different colours. The diary, the space for classified exposures, and the pages for notes and memoranda remain as before, while the tables of the sensitiveness of the various plates and papers on the market and the general information on photographic procedure are brought up to date. The book is a model of compactness and usefulness.

OUR ASTRONOMICAL COLUMN.

SCHORR'S COMET.—The following continuation of the ephemeris of this comet, for Greenwich midnight, is from the elements given in NATURE for December 19, 1918:—

	R.A. h. m. s.	N. Decl. ° ′	Log r	Log Δ
Jan. 2	3 57 47	13 45		
6	3 58 20	14 3	0·4015	0·2390
10	3 59 16	14 22		
14	4 0 33	14 41	0·4144	0·2751
18	4 2 13	15 0		
22	4 4 12	15 19	0·4271	0·3104
26	4 6 22	15 38		
30	4 8 53	15 57	0·4394	0·3448

Magnitude 15.

The following observations have been received:—

G.M.T.	R.A. h. m. s.	N. Decl. ° ′ ″	Observer	Observatory
Nov. 29·8297	4 7 37·6	11 47 47	Burton	Washington (Naval)
30·6602	4 7 4·2	11 49 47	,,	,, ,,
30·7466	4 6 59·5	11 49 56	Barnard	Yerkes

BORRELLY'S COMET.—This comet was observed by Mrs. Freeman with a 3-in. telescope on December 23. It is now growing fainter, but should be observable until the end of January:—

Ephemeris for Greenwich Midnight.

	R.A. h. m. s.	N. Decl. ° ′	Log r	Log Δ
Jan. 5	6 41 18	60 19	0·1776	9·7803
9	6 36 45	62 3	0·1825	9·8026
13	6 32 34	63 26	0·1876	9·8256
17	6 29 43	64 30	0·1930	9·8488
21	6 27 27	65 16	0·1984	9·8717
25	6 26 38	65 48	0·2041	9·8947
29	6 26 50	66 7	0·2098	9·9171

"THE COMPANION TO THE OBSERVATORY, 1919."—This useful work of reference is similar in form to recent issues. In addition to a summary of data from the Nautical Almanac, it contains Mr. Denning's list of meteor radiants for every night of the year, and ephemerides of variable stars classified into five types (Long Period, Algol, β Lyræ, Cluster, and Cepheid). The pages on double stars are due to Mr. Jonckheere; he gives recent observations of 128 pairs and ephemerides for 44. There are several tables of astronomical constants. The magnetic elements for Greenwich direct our attention to the increase in the rate of change in the westerly declination. It is now diminishing at the rate of 1° in six years, and should reach zero about the end of the century.

A misprint on p. 7 may be noted. The dates of planetary quadrature and station are all printed a line too high, opposite the wrong planet's name.

REDETERMINATION OF THE ORBIT OF 588 ACHILLES.—Mme. Julie M. Vinter Hinsen undertook the rediscussion of the observations of this number of the Trojan group made during the decade succeeding its discovery in 1906 (Copenhagen Observatory Publications, No. 29). Some trouble was caused by the fact that the object observed in October, 1914, proved not to be identical with Achilles. Omitting this, all the remaining normal places could be satisfied with no errors exceeding 6″. The following is the final orbit:—

Epoch and Osculation 1907 May 28 Berlin Mean Noon.

$$\left.\begin{aligned} M &= 84^\circ\ 3'\ 1{\cdot}9'' \\ \omega &= 125^\circ\ 36'\ 22{\cdot}4'' \\ \Omega &= 315^\circ\ 35\ \ 58{\cdot}5'' \\ i &= 10^\circ\ 18'\ 13{\cdot}7'' \end{aligned}\right\} 1910{\cdot}0$$

$$\phi = 8^\circ\ 36'\ 13{\cdot}1''$$

$$\mu = 295{\cdot}96333''$$

$$\log a = 0{\cdot}719179$$

THE MANCHESTER EXHIBITION OF BRITISH SCIENCE PRODUCTS.

ON Thursday, December 26, there was opened without ceremony, in the Municipal College of Technology, Manchester, a replica of the British Scientific Products Exhibition held in August and September last in King's College, London, under the auspices of the British Science Guild. The London exhibition attracted much attention and commanded a large attendance of the public interested in the progress of applied science in the United Kingdom, especially as a result of the circumstances induced by the war. It proved that much had been accomplished despite unfavourable conditions as to the supply of certain products, some of them of prime importance, inasmuch as they rank as "key" products upon which certain great industries depend for their successful prosecution.

It was felt that the exhibition should be brought

right to the centre of the great manufacturing areas of the country, and at Manchester a committee was formed under the presidency of the Lord Mayor with this intention. A guarantee fund was raised from manufacturers and others to meet the necessary expenses of organisation and equipment. The Education Committee willingly granted the free use of the spacious and convenient rooms and corridors of the College of Technology for the display of the exhibits, and every facility was afforded by the executive committee of the British Science Guild with the view of inducing the exhibitors at King's College to exhibit at Manchester.

The total number of firms contributing to the present exhibition is about two hundred and forty, including some sixty which did not make any display at King's College. These are chiefly textile firms and firms engaged in the manufacture of chemical or special engineering products. At Manchester, as might be expected, there is a specially fine show of dyestuffs and of intermediate products necessary for their manufacture, together with a fine exhibit of British-made synthetic indigo, the most important of all dyestuffs. Along with these is shown a fine display of goods dyed and printed therewith. There is also an excellent show of magnetos, exhibiting their dissociated parts, with specimens of the raw materials used, and arrangements are made to run the magnetos so as to show the ignition sparks produced for engines with various numbers of cylinders. The manufacture of these appliances, previously almost entirely in German hands, has been greatly stimulated by the requirements of the war, which has, without doubt, resulted in the establishment in this country of a highly essential branch of industry. The exhibition also includes an extensive display of gas- or oil-fired furnaces for hardening high-speed steel, for testing refractory materials, or for forging.

In the large hall of the college is displayed a standard Avro aeroplane, on which 40,000 pilots have been trained. It was the first machine to make a long-distance raid in Germany—Friedrichshafen, November, 1914—and the first to bring down a Zeppelin. Some beautiful specimens are shown of cotton-pile fabrics in successful imitation of Lyons silk velvets, and of printed cotton voiles and cretonnes and dyed cotton-threads. There is an extensive and typical collection of fine chemicals, and also of intermediate products used in organic syntheses for dye manufacture and for explosives. Some interesting chemical products are also shown prepared in the laboratories of the University of Birmingham according to the specifications of certain German patents or modifications thereof suitable for use as high explosives. The "Flatters" method of water colloid doping is shown as applied to gas-proof cloths and to aeroplane-wing cloths, together with micro-photographs illustrating the "permeability" of the acetate cellulose method as compared with the water colloid method of treatment. There is an excellent display of aluminium, showing its preparation from the ore to the finished material and its application to various uses, including automobile parts of all kinds and aeroplane parts, together with electrical equipment, with bare and insulated cables, bus-bars and feeders, traction motor and lifted magnet windings, etc.

Precision machinery and measuring instruments and gauges to a high degree of accuracy are strongly in evidence, together with pressure gauges, aeroplane-radiator thermometers—many thousands of which were made during the war by women labour—and optical pyrometers for measuring temperatures of from 700° to 4000° C., formerly made exclusively in Germany, but manufactured in this country since 1914. A notable exhibit is that of accelerine (paranitrosodimethylaniline), a powerful catalyst of the vulcanising process, the effect of which was discovered in 1914 by S. J. Peachey, working in the laboratories of the College of Technology, Manchester. The addition of 0·3 to 0·5 per cent. of the weight of the material to a rubber mixing reduces the time of vulcanisation to one-third of the normal, and it is now being used by many of the largest rubber and cable works. Examples are shown of six-score "Diatrine" paper-insulated and lead-sheathed cable suitable for a working pressure of 11,000 volts, provided with Glover's patent test sheath. There is also an exhibit of acid-resisting materials and vessels so necessary to meet the urgent demand which arose during the war for these indispensable requirements. The War Office Aircraft Fabrics Department of Manchester displays aircraft and kite-balloon fabrics and apparatus for testing the permeability of aircraft fabrics.

Interesting exhibits are also to be found illustrating various physical apparatus, such as polarimeters, wave-length spectrometers, Hilger vacuum spectrographs, aero-tensionmeters for the accurate and rapid measurement of the tautness of doped and varnished fabrics for aeroplanes, projection comparators for the rapid testing of screw-threads, together with examples of photographic micro-scales and graticules made by grainless, filmless, ceramic, and metallic deposition methods, as well as other forms of micro-scales, which were before the war a German monopoly, and a series of colour-films for scientific and technical purposes.

The catalogue includes, by permission of the British Science Guild, the various valuable scientific and technical articles prepared by recognised authorities which appeared in the London exhibition catalogue, and added considerably to the value of it. In addition, a chapter is devoted to recent researches by the staff and advanced students of the College of Technology, which cover a wide range of subjects, including many investigations required for naval and military purposes which have been found to be "of extreme value." In the electrical engineering department researches have been carried out under the auspices of the Institute of Electrical Engineers on the electrical and mechanical properties of porcelain and on the electrical properties of oils. Experimental work has been successfully completed upon a wattmeter for very heavy alternating currents, and a research concluded upon the existence or non-existence of an action between masses analogous to mutual induction between electrical circuits. The experiment showed that if any such action did occur, the ratio of the change of momentum in the body acted upon to the change of momentum of the acting body was less than $4{\cdot}3\times10^{-10}$. The paper excited considerable interest at the meeting of the British Association in 1915. Investigations were conducted upon the eddy current losses occurring in the end plates of turbo-generators, and a formula deduced by which these currents could be estimated. Many important commercial applications have resulted from researches upon the commutation of continuous-current generators and rotary converters. The municipal and sanitary engineering department has been engaged upon matters relating to the heating and ventilation of buildings, upon the design, construction, and use of material for artisans' dwellings and on town-planning matters, and upon experiments on the strength of lead and other pipes used for the distribution of water.

In the chemical department experiments have been undertaken on the sulphonation of oils under the

auspices of the Society of Dyers and Colourists, and a further investigation on the nitration of oils has been begun, and under the research scheme of the Institution of Electrical Engineers work is now being done concerning insulating oils. The study of the chlorination products of rubber, one of which, known as "duroprene," is remarkable for its resistant and other properties, has been taken up. Research on fuels has included: heating by gas, the stripping of coal-gas, the distillation of cannel and other coals, as well as exhaustive examinations on certain products obtained from coal-mines, and also upon a series of seams of Lancashire coal. The conditions of carbonisation of iron, especially in case-hardening; the influence of impurities on the strength and on the resistance to corrosion of cast-iron; the influence of sulphur in the processes for making malleable iron castings, and on the toughening of copper and increasing the strength of copper alloys, have all been the subject of investigation and experiment with valuable results which have found industrial applications, whilst research on cellulose subsidised by the Department of Scientific and Industrial Research has also been in progress.

In the department of printing and photographic technology investigations were carried out, and are still proceeding, on the development of machine-printed photogravure, and much attention has been paid to new methods for the production of lithographic printing surfaces in monochrome and colour.

Much other research has been carried out or is in progress on the economic use of fuel, on air pollution, on gas flames, on the economic use of electricity for heating purposes, on fibre testing, and on the use of ramie waste for gas-mantles.

All the departments of the college have throughout the period of the war been busily engaged on investigations in aid of the requirements of the several departments of the Government. The results of some of the researches engaged in are shown in the space allotted to the college at the exhibition. It is to be hoped that the exhibition so happily inaugurated in London will serve to convince the public that British science intelligently applied can, if we so will it, contend successfully with the best efforts of the most highly educated of foreign nations.

THE CONCEPTION OF THE CHEMICAL ELEMENT AS ENLARGED BY THE STUDY OF RADIO-ACTIVE CHANGE.[1]

IF a chemist were to purify lead from silver, and found on re-examining the lead that silver were present, and if, again and again, silver, initially absent, reappeared, the doctrine of the unchangeability of the elements would be at an end. The conclusion in 1902 by Sir Ernest Rutherford and myself with regard to the element thorium was of this direct and simple character. As often as the constituents responsible for the radio-activity are separated by physical or chemical means, they reform. One of the constituents, the thorium emanation, is a gas which was shown to possess the complete absence of chemical character characteristic of the argon family of gases. It is formed from thorium through the intermediary of another constituent, thorium-X, which is left in the filtrate, when a solution of thorium is precipitated by ammonia, but not by other chemical reagents. In turn the emanation changes into non-volatile products causing the active deposit. The clear conception of the nature of chemical change, the distinction between atoms and molecules, which we owe to the founders of chemistry, made it possible to recognise radio-active change almost instantly as a case of spontaneous transmutation. Novel as the explanation was, the phenomena explained are so novel as to transcend what to a generation ago would have appeared as the limits of the physically possible. But even to-day it is only in radio-active phenomena that the limits reached long ago in the chemical analysis of matter have been overstepped, and the rubicon, which many have vaulted over so lightly in imagination, has actually been crossed by science.

The first phase of the study of radio-active change was mainly concerned with the disentanglement of the long and involved sequence of transformations which, starting from uranium and thorium, were ultimately found to include all the known radio-elements. Beyond the fact that the radio-elements were in present course of evolution, it added little to the conceptions of chemistry. But in the second and more recent phase—concerned with the chemical character of the successive products, the law connecting this with the type of ray expelled in the change, the discovery of elements with unique radio-active but identical chemical and spectroscopic character, the identification of these as isotopes, or elements occupying the same place in the periodic table, the interpretation of the latter and the recognition that the so-called chemical elements are in reality heterotopes, or substances occupying different places in the periodic table, and are not necessarily even homogeneous—conclusions, not merely novel, but upsetting, have been reached.

The criterion at first relied upon in the analysis of matter into its elements, the possession of a unique chemical character, was added to by Dalton's atomic theory, which gave to each element a unique atomic weight. The periodic law apparently connected these two criteria, fitted the individual elements into families, and showed that, whatever the elements were, they were all of a class, the limits of chemical analysis, and, if complex, then all of the same kind of complexity. The periodic law introduced a third criterion of the element, that it occupied a place to itself in this scheme, and the discovery of spectrum analysis, a fourth, that it possessed a unique spectrum. The discovery of radio-activity introduced a fifth, the possession of a unique radio-active character, in the case of the radio-elements. Of the first three new elements discovered by the aid of the fifth criterion, polonium, actinium, and radium, the claim of the last to the title of element was brilliantly substantiated by the successive determination of its unique spectrum, unique chemical character, unique place in the periodic table, and unique atomic weight. The production of this element from uranium through the intermediary of ionium, and the production of helium from radium, and, in due course, from the other radio-elements, furnished conclusive proofs of the correctness of the first interpretation of the transmutational character of radio-active change.

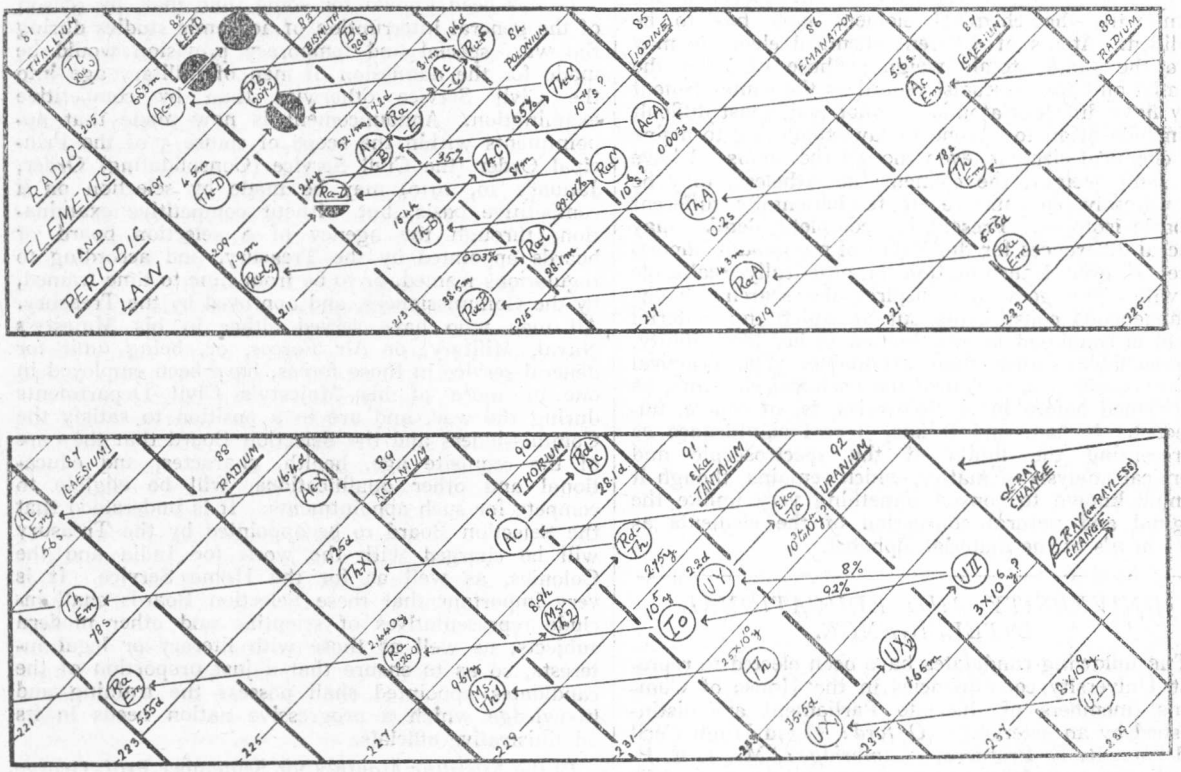
Then came a totally new departure. The possession of unique radio-active character does not always, as in the case of radium, connote unique chemical and spectroscopic character. As, one after another, the various members of the disintegration series were distinguished, by their breaking up in characteristic ways at definite rates, no further *chemically new* elements were found. All resembled known elements so closely that they could not be separated by chemical analysis, and those actually at work on these substances came to the conclusion that the chemical resemblances amount to identity. Radio-thorium is, for example, identical chemically with thorium. It was isolated from thorium and individually recognised by Sir William Ramsay and O. Hahn only because it is

[1] Summary of a lecture delivered to the Chemical Society, December 19, 1918, by Prof. Frederick Soddy, F.R.S.

formed from thorium through an intermediate product, mesothorium, chemically different from thorium, but chemically identical with radium. No more elegant addition, not merely to knowledge, but also to the means of winning knowledge, can be imagined. Two separate substances, radio-thorium and thorium, in the original analysis of the thorium disintegration series, taken for one, become individually knowable, because the first is formed from the second through a third substance chemically totally distinct from either. Radio-active change thus furnished a new means of analysis, for which, outside the radio-elements, there is as yet no equivalent.

Further work on the chemical character of the various members of the disintegration series, notably by Fleck, who showed that practically all were chemically identical either with some common element or other radio-element, in 1913 paved the way for the generalisation independently arrived at by Russell, Fajans, and myself, which is brought up to date and illustrated by the accompanying figure. Each α-ray change was found to cause a shift of two places in the periodic table in one direction, and each β-ray change a shift of one place in the other, the first change being accompanied by a reduction of four units of atomic mass, a helium atom being expelled, and the second not involving a sensible loss of mass. Thus the successive places in the periodic table were first associated with unit variation of atomic charge, for the β-particle is the negative electron, and the α-particle a helium atom carrying two positive atomic charges. The elements with identical chemical character were found to occupy the same place in the periodic table, and were, therefore, termed isotopes. Conversely, the elements recognised by chemical and spectroscopic analysis may be termed heterotopes.

In the figure, which is to be read at 45°, the numbers at the head of each place—92 for uranium, and so on—are the atomic numbers, or number of the place in the complete list of places in the periodic table, as determined by Moseley, on the assumption that the atomic number of aluminium, the thirteenth element in the list, starting from hydrogen, is 13. The period of average life of each member is shown above or below its symbol, a "?" indicating that the period is indirectly estimated from the range of the α-ray expelled. The last member to be added, eka-tantalum or proto-actinium, the direct parent of actinium in an α-ray change, was discovered this year independently by Cranston and myself, and by Hahn and Meitner. For this element, for actinium, and for polonium, but for none of the others, are the criteria of unique spectrum and chemical character, as found for radium, to be expected. Moreover, the period of eka-tantalum, as estimated from the range of its α-rays by Hahn and Meitner, makes it appear that in due course determination not only of the spectrum, but also of the atomic weight and complete chemical nature, of this element will be possible. It is only in this way that the open question whether the actinium series branches off as shown at uranium-II or at uranium-I can be settled.



As the figure shows, so far as the changes have been followed, they all result in the production of isotopes of lead ranging in atomic weight from 206 to 210, the main products being that of uranium, 206, and both thorium products in the two branches, 208. The conclusion that lead was the ultimate product of thorium was new, but the prediction that the ultimate products of both uranium and thorium are different isotopes of lead—the one with an atomic weight less, and the other with an atomic weight greater, than that of common lead, 207·2—has been completely confirmed by experiment, and it has also been shown that ionium has an atomic weight lower than thorium (compare NATURE, July 19 and 26, 1917).

The older chemical analysis of matter distinguished only heterobaric heterotopes. The newer methods

depending on radio-active change distinguish, not only heterobaric, but isobaric isotopes, and also isobaric heterotopes—that is, substances of different atomic weight and identical chemical character, of the same atomic weight and chemical character, and of the same atomic weight and different chemical character. A glance at the chart will show many examples of all three kinds. Not only has the chemical element been robbed of its time-honoured title to be considered the ultimate unchanging constituent of matter, but its title to be considered homogeneous has also vanished. The century that began with Dalton and ended with the discoveries of Becquerel and the Curies took the practical conception of the element it found extant, as that which could not be further resolved, and made of it the central conception of a theory of the ultimate constitution of matter. The element was first atomised, and then the atom and the element became synonyms, related as the singular is to the plural. Every one of the conceptions which associated the atom with the chemical element now has to be modified. Atoms of different chemical elements may have the same atomic weight; those of what the chemist and spectroscopist regard as the same element may have different atomic weight; and, most difficult to include of all to anyone to-day attempting to define the chemical element, even though the atoms all have the same weight, the element, nevertheless, may be an unresolvable mixture of fundamentally different isobaric isotopes. Present-day complete identity may conceal differences for the future of paramount importance, if ever transmutation is practically realisable at will. The goal that inspires the search for the homogeneous constituents out of which the material world is composed is now known to be, like infinity, approachable rather than attainable. The practical and necessary conception of the chemical elements, as understood before these discoveries, is, of course, unaffected. It had, and it has, a real significance as representing the limits of the spectroscopic and chemical analysis of matter, which remains, though it is now known to convey something very unlike the original and natural conception of the elements as the *l m n*'s of the material alphabet.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE following candidates have been elected to represent University constituencies in the House of Commons (members of the late Parliament are distinguished by an asterisk):—*Oxford:* *Lord Hugh Cecil and *Mr. R. E Prothero. *Cambridge:* *Mr. J. E. P. Rawlinson and *Sir Joseph Larmor. *London:* *Sir Philip Magnus. *Combined English Universities:* *Mr. H. A. L. Fisher and Sir Martin Conway. *Wales:* *Mr. J. Herbert Lewis. *Scotland:* *Sir Watson Cheyne, Mr. D. M. Cowan, and *Sir Henry Craik. *Dublin:* *Mr. A. W. Samuels and Sir Robert Woods. *National:* Mr. J. MacNeil. *Queen's (Belfast):* Sir William Whitla.

THE National Education Association, Caxton House, Westminster, has prepared and published a useful summary of sixteen quarto pages (price 6*d.*) of the Education Act, 1918, in which the Act is succinctly summarised and explained. The pamphlet further contains a brief *résumé* of each of the sections of the Act, in which is included only the operative words and phrases grouped under special headings, such as the "Organisation of Education," "Co-operation and Combination," "Expenditure," "Attendance at Continuation Schools," "To Aid Research," "Central Schools and Classes," "Education Grants," etc. It will prove exceedingly helpful to members of education committees, to officials engaged in administration, and to the teaching profession, both public and private, since it gives without technical and legal verbiage a clear view of the operations of the Act, and enables them to see how very much of the Act can, even in present circumstances, be brought into immediate operation. Now that the war is practically over it may be assumed that the Board of Education, as it is empowered by the Act, will, so soon as the conditions of peace are arranged and the treaty is signed, bring into operation the vital sub-sections of the Act raising the compulsory age of attendance at public elementary schools to fourteen years in all areas, and empower local authorities to raise by by-law the age to fifteen where so desired. Already a majority of the sections of the Act is in full operation, and it only awaits the conclusion of peace for this, the most important Act of the last session of Parliament, to come into full and salutary effect.

IT has been known for some time that, by reason of the general interruption of academic studies during the war, special and temporary provision would be made for the admission of men of military age into the Civil Service otherwise than by competitive examination. Announcement is now made that appointments within the scope of clause 5 of the Principal Order (the Civil Service (Consolidating) Order, January 10, 1910) may be made by selection on a competitive basis, but without competitive examination, through the agency of a selection board or boards appointed by the Treasury, and according to regulations framed, or to be from time to time framed, by the Commissioners, and approved by the Treasury. All men who have served either in his Majesty's Naval, Military, or Air Forces, or, being unfit for general service in those forces, have been employed in one or more of his Majesty's Civil Departments during the war, and are in a position to satisfy the Commissioners and the Selection Board that they are of the requisite age, health, character, and educational and other qualifications, will be eligible to compete for such appointments. It is understood that the Selection Board to be appointed by the Treasury will be charged with the work for India and the Colonies, as well as for the Home Service. It is very important that these Selection Boards shall include representatives of scientific and other modern subjects, as well as those with literary or legal interests, so as to ensure that a just proportion of the candidates appointed shall possess the training and knowledge which a progressive nation needs in its administrative officials.

IN the *Scientific Monthly* for September Prof. George Sarton has an article on "The Teaching of the History of Science," which gives further insight into his ideas on this subject. Just as a skilled workman employed day by day on the one job he can do best runs the risk of becoming a human machine, so the scientific investigator who devotes his life to one particular field of research is in danger of losing touch with reality. The workman may gain a broader outlook over the work on which he is engaged by attending evening classes at a technical institute; for the scientific investigator Prof. Sarton recommends lectures on the history of science. The lecturers on this subject would give comprehensive surveys of the whole field of science, illustrating their lectures, so far as possible, with models and simple experiments. The author considers that each university should establish three such courses:—(*a*) An introductory course on the history of science throughout the ages; (*b*) the history of a particular science; and (*c*) the history of science and civilisation at a special period. The two special courses would be changed from year

to year. He would admit to these courses only those who, by having worked successfully in a laboratory, would be in a position to appreciate the instruction. Prof. Sarton insists that the value of this teaching will largely depend upon the soundness of its scientific foundation. The teaching should not be entrusted to literary people, philosophers, or anyone knowing science only in a superficial way, but must be precise and concrete, its chief purpose being to interpret the scientific spirit and methods. The ultimate aim of the courses is to humanise science, and so to give it its due part in a general scheme of education.

SOCIETIES AND ACADEMIES.

LONDON.

Optical Society, December 12.—Prof. F. J. Cheshire, president, in the chair.—Instructor-Com. T. Y. **Baker** and Major L. N. G. **Filon**: An empirical formula for the longitudinal aberration of a ray through a thick lens. The authors showed that the development of the longitudinal aberration as a power series is frequently illegitimate owing to its divergence for comparatively slight inclinations of the rays. Instead of such development of the form $at^2+bt^4+\ldots$, where t is the tangent of the inclination of the ray, they proposed a formula $At^2/(1+Bt^2)$, and determined A and B numerically from the values of the aberration of particular rays calculated trigonometrically through a lens. This was done for a whole series of image positions and for a whole series of lenses of different shapes but of the same focal length. The numerical values of A and B so obtained were then analysed, and an endeavour was made to obtain approximate general formulæ for them in terms of the image position and the lens shape. The authors decided that in all cases the value A in their empirical formula and the value a in the power series were practically identical. The value of a was given by the authors in a paper read before the society in May. The value of B can be expressed as a cubic in M, the linear magnification of the image. Thus $B=B_0+B_1M+B_2M^2+B_3M^3$, in which the four coefficients B_0, B_1, B_2, and B_3 are all quadratic functions of the mean curvature of the lens faces.—Major E. O. **Henrici**: Spirit-levels. The best bubble tubes for spirit-levels have been made in Germany; it seems desirable that an investigation should be made of the factors necessary for producing satisfactory tubes. The advantage of a long air-bubble, as regards both the accuracy and rapidity with which the bubble comes to rest when displaced, was pointed out, and also the advantage of a short radius of curvature as regards the latter point. The radius of curvature (in other words, the sensitiveness) must, however, be sufficiently great for the bubble to move noticeably with the smallest angular tilt of the tube which it is desired to indicate. If the bubble be too sensitive, time is lost; if it be not sufficiently sensitive, a spurious idea of accuracy is given; the sensitiveness of every bubble tube for accurate work should be marked. The methods of mounting, illuminating, and viewing the bubble tube frequently leave much to be desired, and improvements in these matters lead to increased accuracy for a given sensitiveness. Several methods of viewing by means of prisms were described, the most satisfactory known to the author being one placed on the market by Zeiss. The accuracy of shaping the surface required in a sensitive bubble is very great. If a tube has a corrugated surface, the corrugations having an amplitude of 1/2000 mm. and a period of 10 mm., the angle of tilt to move the bubble 1 mm. may vary 38 per cent. from its nominal value in the case of a bubble with a sensitiveness of 10 seconds per mm., the bubble being 35 mm. long. A similar corrugation with a 2-second bubble will make it almost useless for any purpose. Further investigation is required into the effect of the following factors on the performance of the bubble:—Quality, polish, and cleanliness of the glass; quality and purity of the liquid and vapour in the tube, and the best methods of mounting and viewing.

Aristotelian Society, December 16.—Prof. Wildon Carr, vice-president, in the chair.—Prof. J. **Laird**: Synthesis and discovery in knowledge. The paper consisted of a discussion of two sharply contrasted views of knowledge (viz. that knowledge is essentially the inspection or the discovery of an object which is given or revealed, and that knowledge is essentially a process of organisation or construction on the part of the mind), together with a consideration of certain hypotheses designed to mediate between these extreme views. The general argument was that while the first of these alternatives could be defended against many of the objections commonly brought against it, it was ultimately inadequate, since representative construction in words, images, etc., is plainly an integral part of most varieties of knowing. An examination of the theory that knowledge is always the inspection of a construction showed (1) that in this case the product of construction required to be apprehended directly, and (2) that such a product could be known to be representative only if the things represented were directly apprehended, in some instances at least. The theory that knowledge consists of construction (it was claimed) was therefore refuted, and the rest of the argument consisted of a detailed investigation into the truth of the statements that the object of knowledge is always (in some sense) a mental product on the ground that this object is always "a unity" or "a meaning," or that mental imagery is always an essential part of it. The author maintained that these arguments were either fallacious or inconclusive.

PARIS.

Academy of Sciences, December 9, 1918.—M. P. Painlevé in the chair.—E. **Picard** and A. **Lacroix**: The second meeting of the Inter-Allied Conference of Scientific Academies. An account of the resolutions passed at the meeting held at Paris, November 26 to 29 (see NATURE, December 26, 1918, p. 325).—J. **Drach**: Integration of a partial differential equation of the dynamics of fluids.—A. **Buhl**: The extension to multiple integrals of the theorem concerning the exchange of the amplitude and parameter in hyperelliptic integrals.—A. **Lambert**: Certain polynomials connected with Laplace coefficients.—Ch. **Frémont**: A new machine for measuring the resistance of cast-iron by the method of chiselling.—Ch. **Gorceix**: The probable correlation of the displacements of level of the base and the oscillations of glacial fronts.—A. **Guébhard**: A possible conciliation between the two theories of volcanic action.—M. **Molliard**: The saprophytic life of an Entomophthora. This fungus (*E. henrici*), developed originally on a *Culex pipiens*, has been grown successfully on the sterilised grub of *Euchelia jacobaeae*, on sterilised ox-liver, and even on carrot, but in the last-named the cultures are not so abundant as on liver. Hence this species is not necessarily parasitic.—F.-X. **Skupienski**: Sexuality in *Dictyostelium mucoroides*.—L. **Roule**: The state of spawning salmon during their migration into fresh water in France. From the examination of eighty fish taken at different periods it is concluded that for the first two years young salmon live in fresh water, and then descend to the sea, growing there for a period varying from two to four years. Then, at the age of between four and six years, they return to

fresh water for reproduction.—M. **Caullery** and F. **Mesnil**: The initial parasitic phases of *Xenocoeloma brumpti*. Observations on this parasite in various stages of development confirm the interpretation, apparently paradoxical, deduced from the study of the adult.—E. **Roubaud**: Physiological rhythms and spontaneous flight in *Anopheles maculipennis*.—F. **d'Hérelle**: The *rôle* of the filtering bacillus in dysentery. This bacillus exists normally in the intestine. The presence of the Shiga dysentery bacillus in the intestine determines at first a considerable increase in the activity of the filtering bacillus against *B. coli*, and then it becomes capable of causing the gradual or rapid disappearance of the Shiga bacillus. It has been further proved in the case of the rabbit that cultures of the filtering bacillus have preventive and curative action in the disease introduced experimentally.—A. **Vernes** and R. **Douris**: The action of ferric thiocyanate on normal human serum.

December 16, 1918.—M. P. Painlevé in the chair.—M. **Hamy**: The diffraction of solar images.—Ch. **Depéret**: An attempt at the general chronological coordination of the Quaternary period.—M. A. Rateau was elected a member of the division of the application of science to industry, M. Waddell a correspondant for the section of mechanics in succession to the late M. Zaboudski, and Sir David Bruce a correspondant for the section of medicine and surgery in succession to the late M. Czerny.—M. **Valiron**: The general properties of entire functions and the theorem of M. Picard.—M. **Mesnager**: Curves defined by series. Advantages of a change of definition.—M. **Swyngedauw**: The effective resistance and reactance of an armoured triphase cable for the three harmonics of the current.—G. A. **Le Roy**: A mode of mercurial embalming in medieval times. The examination of a material used in embalming John of Lancaster, Duke of Bedford, in 1435 proved it to consist of balsams triturated with metallic mercury.—J. de **Lapparent**: The elaboration of silica and siliceous limestones by algæ of the Girvanella group.—Mme. Valentine Charles **Gatin**: The structure of the peduncle in the flowers of Liliaceæ. The anatomical structure of the floral peduncle in the Liliaceæ forms an anatomical distinction between the different genera of this order, as well as the species of the same genus.—G. **André**: Distribution of the mineral elements and the nitrogen in etiolated plants. About three-fourths of the nitrogen and phosphoric acid present in the seed (haricot) are transferred from the cotyledons to the young plant during twenty-five days' growth in the dark. The redistribution of the sulphur is similar.—J. **Chaine**: Considerations on the general muscular system of the vertebrates.—Ch. J. **Gravier**: The adaptation of the foot to the surrounding medium in the sea anemone at great submarine depths.—MM. **Alezais** and **Peyron**: The characters and origin of a group of tumours wrongly classified with the coccygian class of Luschka. The authors give reasons for regarding these so-called peritheliomas as neoplasts of neuro-epithelial origin arising from vestiges of the caudal segment of the spinal column.—M. **Heitz-Boyer**: The osteogenetic action of dead bone tissue.

BOOKS RECEIVED.

Electro-analysis. By Prof. E. F. Smith. Sixth edition. Pp. xiii+344. (Philadelphia: P. Blakiston's Son and Co.) 2.50 dollars net.

The Botany of Crop Plants. By Prof. W. W. Robbins. Pp. xix+681. (Philadelphia: P. Blakiston's Son and Co.) 2 dollars net.

The Natural Organic Colouring Matters. By Prof. A. G. Perkin and Dr. A. E. Everest. (Monographs on Industrial Chemistry Series.) Pp. xxii+655. (London: Longmans, Green, and Co.) 28*s*. net.

Evolution and the Doctrine of the Trinity. By S. A. McDowall. Pp. xxvi+258. (Cambridge: At the University Press.) 9*s*. net.

Technical Handbook of Oils, Fats, and Waxes. Vol. ii.: Practical and Analytical. By Percival J. Fryer and Frank E. Weston. (The Cambridge Technical Series.) Pp. xvi+314. (Cambridge: At the University Press.) 15*s*. net.

The Physiology of Industrial Organisation and the Re-employment of the Disabled. By Prof. Jules Amar. Translated by Bernard Miall. Edited, with notes and an introduction, by Prof. A. F. Stanley Kent. Pp. xxv+371. (London: The Library Press, Ltd.) 30*s*. net.

A Text-book of Biology for Students in General, Medical, and Technical Courses. By Prof. W. M. Smallwood. Third edition, enlarged and thoroughly revised. Pp. xiv+306+8 plates. (Philadelphia and New York: Lea and Febiger.) 10*s*. 6*d*. net.

DIARY OF SOCIETIES.

MONDAY, JANUARY 6.

ARISTOTELIAN SOCIETY, at 8.—C. D. Broad: Mechanical Explanation and its Alternatives.

TUESDAY, JANUARY 7.

RÖNTGEN SOCIETY, at 8.15.—Dr. H. S. Allen: Electrical Changes Produced by Light.

WEDNESDAY, JANUARY 8.

GEOLOGICAL SOCIETY, at 5.30.

THURSDAY, JANUARY 9.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—M. B. Field The Navigational (Magnetic) Compass as an Instrument of Precision

FRIDAY, JANUARY 10.

ROYAL ASTRONOMICAL SOCIETY, at 5.

THURSDAY, JANUARY 16.

CHEMICAL SOCIETY, at 8.

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