THURSDAY, MAY 15, 1919.

DYNAMICS OF EVOLUTION.

The Origin and Evolution of Life on the Theory of Action, Reaction, and Interaction of Energy. By Prof. H. F. Osborn. Pp. xxxi+322. (London: G. Bell and Sons, Ltd., 1918.) Price 25s. net.

"CONFESSION of failure," Prof. Osborn writes, "is part of the essential honesty of scientific thought." Wave after wave of evolutionary theory has prompted research, but, in spite of many new facts, there has been little fresh enlightenment since Darwin's day. "The chief causes of the orderly evolution of the germ are still entirely unknown." So the author has sought for a fresh starting-point—"an energy conception of evolution." He would take the organon of physico-chemical science for a while, leaving morphology and bionomics to the end. There are four main complexes of energy to be considered — the inorganic environment, the organism, the heredity germ, and the animate environment. How are they adjusted to one another? What in particular are the relations of the heredity germ with the other complexes, for are we not slow to learn Weismann's lesson that the essential question is as to germinal evolution, not as to bodily evolution? The heredity germ remains inconceivable as regards its development, its lineage, and its evolution. Thus, in his preface, Prof. Osborn cleans the slate. His essential honesty is a little depressing, but the general idea is: We have been thinking too much from Form backwards; let us try to think from Energy forwards.

Organisms as material systems are solidary with the inorganic, but they are distinguished by their more dominant constructive capacities, as Joly pointed out very clearly long ago. Besides the actions and reactions (capturing, storing, releasing energy) which conform to the second law of thermodynamics, there is in organisms a distinctive dominance of "interactions" which unify or integrate—*e.g.* nervous impulses or chemical messengers. "Interaction" has to do with the co-ordination, balance, co-operation, compensation, acceleration, and retardation of actions and reactions. In the course of development there is evidence of this correlating and regulating, which Prof. Osborn is not felicitous in calling "the directing power of heredity." The central thought of the book is thus stated: "In each organism the phenomena of life represent the action, reaction, and interaction of four complexes of physico-chemical energy, namely, those of (1) the inorganic environment, (2) the developing organism (protoplasm and body-chromatin), (3) the germ or heredity-chromatin, (4) the life environment. Upon the resultant actions, reactions, and interactions of potential and kinetic energy in each organism selection is constantly operating wherever there is competition with the corresponding actions, reactions, and interactions of other organisms." The author is quick to add that, "while this is a principle which largely governs the organism, it remains to be discovered whether it also governs the causes of the evolution of the germ." This is Prof. Osborn's "tetrakinetic" or "tetraplastic" theory.

The constructive part of the book opens with an interesting discussion of "the preparation of the earth for life," the capture of the sun's heat and light, the suitability of various elements to function in metabolism, and similar topics. As to the primary physico-chemical stages of life, the following steps are speculatively suggested: The assemblage of several of the ten elements now essential to life, the integration of these in a novel way ("a new form of unity in the cosmos") and in a state of colloidal suspension, the appearance and specialisation of catalysers (effecting biochemical co-ordination and correlation), the beginning of competition and natural selection. What primordial life-forms competed about we are not told; probably for a place in the sun. The attractive agency of hydrogen and oxygen led to the incorporation of additional elements useful in energy-capture. But no great progress was possible until interactions were established which regulated and unified metabolism; and a vivid account is given of the variety of chemical messengers, both general and specific, which play so important a *rôle* in the economy of the organism.

Prof. Osborn then passes to consider bacteria as the forerunners of ordinary plant and animal protists; they show the capture, storage, and utilisation of energy in simplest expression; they form the primordial food supply; they lead on to the first true cells with differentiated protoplasm and chromatin. Through the chromatin, excelling all other substances in the complexity of its molecular constitution, it became easier for an organism to retain its integrity amid ceaseless metabolism and from generation to generation. Another great step with incalculably important results was implied in the appearance of chlorophyll, which hitched organisms in a new way to the sun, facilitating energy-capture enormously.

In the second part of his book Prof. Osborn deals with the evolution of animal form, and proves himself an entertaining and illuminating guide. What seemed to us in earlier pages an over-emphasis on the adequacy of physico-chemical formulations is now corrected by a recognition of psychic powers which are in an indirect way "creative of new form and new function." In the vivid sketch of the evolution of vertebrates there are very valuable features, notably (*a*) the correlation of organismal and environmental changes; (*b*) the illustration of adaptive radiation of group after group to the twelve chief habitats; (*c*) the continual facing of the difficulty that, unless one is a thoroughgoing Lamarckian, the sources of the raw materials of evolution must be looked for in the heredity germ, not in the organism; in the genotype, not in the phenotype; (*d*) the recognition of the simultaneous and cor-

M

related evolution of a multitude of characters in one organism (which is aptly likened to an advancing army with units, companies, and regiments); (*e*) the importance of what we venture to call temporal variations—*i.e. plus* and *minus* changes in the rate or *tempo* of the evolution of various parts of the body, which may perhaps be correlated with variations in glands of internal secretion; (*f*) the insistence on the palæontological evidence, which has accumulated since Waagen's day, thanks in great part to Prof. Osborn's own industry, that the evolution of characters often proceeds by minute and definite changes; and (*g*) what we confess to having an incorrigible pleasure in welcoming, an admission that the "initiative" of the organism counts. Prof. Osborn's concept of "interaction" does not seem to us to differ from the concept of "correlation" or "integration" with which many of us have worked, but perhaps he has done more justice to it than have others. At any rate, his clear view of the dynamical aspect of the organism has resulted in an uncommonly fresh and stimulating book which will make many students of biology grateful. We wish we had space for more than a word of praise for the abundant illustrations, which are very original and telling.

J. A. T.

EXPERIMENTS IN BIOLOGICAL METHOD.

(1) *The Quantitative Method in Biology*. By Prof. Julius MacLeod. ("Publications of the University of Manchester," Biological Series, No. 11.) Pp. xii+228. (Manchester: University Press; London: Longmans, Green, and Co., 1919.) Price 15*s*. net.

(2) *A Text-book of Biology. For Students in General, Medical, and Technical Courses*. By Prof. William Martin Smallwood. Third edition, enlarged and thoroughly revised. Pp. 306. (Philadelphia and New York: Lea and Febiger, 1918.) Price 10*s*. 6*d*. net.

AT intervals, in every science, investigators and teachers begin to become dissatisfied with accepted methods. They come to realise that the methods in vogue were adapted to a certain stage in the development of the science, and that as the science progresses changes both in the means of investigation and in the manner of teaching become needful. The two books under review have one feature, and perhaps only one, in common; they both are attempts to introduce improved methods, the one in investigation, the other in teaching.

(1) Prof. MacLeod, of Ghent, while resident at Manchester, has continued his studies on what might be called biometry were not his methods so different from those of the English school of biometricians, and expounds his aims for the benefit of British readers. He tells us that in the physical sciences "the properties of objects are measured and expressed by means of figures called *constants*," while in biology "the properties (characters) of the living things are usually described by means of terms" (long, short, narrow, oval, etc.). "The object of the present book is to describe a method by which biological constants may be established." He begins by assuming that there is a chemical basis for species, for the living basis of each species is a mixture of chemical substances, and these specific mixtures differ from one another by at least one entity. Species are thus essentially discontinuous, but every specific property is the resultant of a reaction between the specific mixture and environmental forces. Hence arises *plasticity*—the variation of species due to environmental differences. Variation due to plasticity and that due to germinal change can be investigated adequately only by quantitative methods, as is recognised by both the biometric and Mendelian schools. But exact methods are needed, especially in systematic biology, and also in embryology, comparative anatomy, and physiology, and it is suggested that many new facts and ideas would come to light if this were more generally recognised. For this purpose the author seeks in each species investigated a number of simple properties, analogous with Mendelian unit characters, which can be observed and recorded accurately. These he calls *primordia*, and they are such that each is the expression of a state of equilibrium at the time when it is observed, though it may disappear or change to a different primordium later. For example, the petals of the forget-me-not are first white, then pink, then blue; white and pink are transitory primordia, blue is persistent. Most primordia chosen are measurable—lengths, numbers of segments, and so forth—but such features as colour or texture may also be used.

By means of the study of such primordia, made by the author chiefly in plants and insects, a number of principles are deduced, with which all biologists are familiar in an indefinite sense, but which are rarely expressed in a concrete form. Of these may be mentioned especially *gradation*, defined as the variation of a given property along a given axis (as, for example, the lengths of successive internodes in plants), and also a number of curious and ingenious comparisons between organic variation and the numerical results of chance in regard to the tossing of coins, throwing of dice, etc.

The main aim of the book, however, is to show that by making sufficient measurements of independently varying "primordia" true biological constants are obtained. For if a sufficient number of specimens are examined (and the author shows that this number need not be excessively large), the maximal, and sometimes also the minimal, value of each primordium is "a strictly determined biological constant," so that a collection of such constants is not only an adequate and easily used diagnosis of the species, but may be used also for the study of development, comparative anatomy, and the influence of environment (plasticity). Though the book contains much that is interesting, a large part of it affords but tedious reading; somehow it suggests that organisms looked at in this light are not, and never have been, *alive*. That we should learn much if Prof. MacLeod's method were adopted is probably very true, but it is difficult to imagine any large number of biologists adopting it.

(2) Prof. Smallwood's "Text-book of Biology" is of a very different character. It is an introduction to biology for elementary students, planned so as to retain the main features of the "type" system, while at the same time offering a much wider outlook on the subject than is given by most other books of the kind. It has reached a third edition, and therefore doubtless meets a real want, and yet it cannot be called satisfactory. In 300 pages largely occupied by figures, mostly very good, it attempts to treat almost every known aspect of biology, and the impression given is "a little of everything and not enough of anything." A good elementary text-book based on biological principles rather than on types is certainly much to be desired, but it will not be easy to write, and the volume under notice, though an attempt in that direction, is by no means an unqualified success. L. D.

INDUSTRIAL ELECTROLYSIS.

The Applications of Electrolysis in Chemical Industry. By A. J. Hale. (Monographs on Industrial Chemistry.) Pp. ix + 148. (London: Longmans, Green, and Co., 1918.) Price 7*s.* 6*d.* net.

THIS is one of the volumes of the series of "Monographs on Industrial Chemistry" now being published under the general editorship of Sir Edward Thorpe. The author is demonstrator and lecturer in chemistry at the Finsbury Technical College; his book is well printed and illustrated, and contains copious references to the patent and other literature of the subject.

The work is divided into an introduction and eight chapters. The introduction and chap. i. (thirty-two pages in all, or two-ninths of the book) are devoted to the discussion of the general principles of electrolysis and methods of generating the current; the remaining seven chapters, extending to 111 pages, have to suffice, therefore, for the special subject with which the book deals—namely, industrial electrolysis. The compression required to cover the ground in the allotted space is, in fact, rather too severe a handicap for adequate treatment, and the book would have gained in value had its length been doubled. As it is, two chapters have been given to the extraction and refining of metals, and two chapters to the electrolysis of alkali chlorides; while one chapter each is devoted to the electrolytic production of the gases hydrogen and oxygen, of inorganic colours, and of organic compounds such as iodoform, anthraquinone, etc.

The description of particular processes and cells is necessarily brief, and in the circumstances the author would have been wise to devote less space to the earlier patents and processes of electrolysis (many of them no longer in operation), and to give more detailed descriptions of the processes and cells now in actual use. For example, the Acker process of caustic soda manufacture by the electrolysis of fused salt has not been a success as a practical process, yet the author has devoted nearly two pages and two illustrations to his description of it, and some of the other cells and processes dealt with are similarly only of historical interest.

As Sir Edward Thorpe pointed out in his general introduction to the series of monographs to which this volume belongs: "In some cases, where the subjects touch the actual frontiers of progress, knowledge is so very recent, and its application so very tentative, that both are almost certain to experience profound modification sooner or later. This, of course, is inevitable." It is a pity that the author has increased this handicap of "being out of date before it appears" by including matter in the present volume that is only of historic value.

However, the work will prove of considerable value to students of electro-chemistry who wish to obtain a rapid survey of its industrial applications, and also to engineers and chemists who wish to trace the development of particular processes. As already stated, there are copious references to the earlier journal and patent literature, and good subject-matter and name indexes, which add to the value of the book as a reference work on the subject with which it deals. J. B. C. K.

OUR BOOKSHELF.

America at School and at Work. By the Rev. Dr. H. B. Gray. Pp. xx + 172. (London: Nisbet and Co., Ltd., 1918.) Price 5*s.* net.

THIS is a highly valuable contribution to the solution of present-day educational problems. Dr. H. B. Gray was joint author with Mr. S. Turner of a stimulating book issued in 1916 entitled "Eclipse or Empire?" The present work is the fruit of an extensive tour in the United States during the spring and summer of 1917, especially among the educational institutions of the prosperous States of the Far West least affected by European influences, and is a remarkable revelation of the spirit of enterprise shown by these States. The author is unstinting in his praise of the "magnificent and far-reaching measure" known as Mr. Fisher's Education Act of 1918, from the operations of which he anticipates the most fruitful results for the future well-being of the nation.

America has a tremendous problem to face—namely, to turn into good American citizens in the shortest time possible the great stream of immigrants which annually comes to its shores from all parts of the European world, and the instrument by which this salutary result is accomplished is chiefly the English language, the medium for which is the elementary or grammar school, the high school and the technical schools, and finally the college or the university. "Education is designed for the masses, and not for the classes," so the author writes, and "it is the birthright of every citizen." And so education becomes to the American youth his one inalienable asset. The author contrasts the enormous provision made in the States with that made in this country in the way of private benefaction and Government, State, and city grants, not only in aid of general education for all classes, but also in the means of continued education and the support of research as applied to agriculture and manufacture, and especially refers to the great industrial and commercial corporations which provide means for the thorough education of their apprentices.

The book is full of most interesting examples of the varied ways in which education for, and during the preliminary stages of, a vocation is made accessible. Administrators of education will find the book both a useful guide and a much needed stimulus.

Catalogue of Lewis's Medical and Scientific Circulating Library, including a Classified Index of Subjects, with the Names of those Authors who have treated upon them. New edition, revised to the end of 1917. Pp. 492. (London: H. K. Lewis and Co., Ltd., 1918.) Price 12*s*. 6*d*. net.

THIS library catalogue is in two parts. A list of the books arranged in the alphabetic sequence of the authors' names occupies the greater part of the volume, and is followed by an alphabetical list of subjects. In the author index the title of each book, its published price, and date of publication are given. Although the published price may give some idea of the size of a book, it would improve the catalogue if the number of pages in each case were stated. We would also suggest that for indicating the size of pages an approximate statement of the height and width of the page in inches or centimetres is more useful as well as more accurate than such expressions as 12mo, cr. 8vo, and roy. 8vo.

The second part of the catalogue is its most interesting feature. This is an alphabetical list of subjects, the cross-references to the main list of books being merely the names of authors. Thus under "Molecules" we find Kelvin and Turner. Turning to the author index, we are led to Lord Kelvin's lectures on "Molecular Dynamics" and to W. E. S. Turner on "Molecular Association." As there are thirteen Turners in the list, it would have been better to give the author's initials in the subject catalogue. Indeed, this should be done whenever there are several authors with the same surname.

Although this catalogue has been compiled for a particular library, it will be helpful to those who are forming libraries of their own, the list of modern scientific books in the English language being very comprehensive.

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.*]

"Camouflage" of Ships in War.

IN his speech at the Royal Academy banquet the Prince of Wales referred to one of the factors of modern warfare which is of special scientific interest—the art of "camouflage." In the highly successful "camouflage" of ships as it was carried out during the closing phases of the war the principle made use of was that, familiar to biologists, of breaking up continuity of surface and outline by violent colour contrasts.

I happened to have become specially interested in this problem of the "camouflage" of ships long before the war through a peculiar concatenation of circumstances:—(1) I was professionally interested as a biologist in the obliterative colouring of animals; (2) during my sojourns in the Gran Chaco during the years 1889–91 and 1896–97 I had had the extraordinary efficiency of Nature's methods of obliterative colouring constantly brought home to me by practical experience; and (3) when present at the opening of the Kiel Canal in 1895, as one of the crew of Mr. W. B. Hardy's yacht *Raven*, I was particularly impressed by the fact that, whereas the ships of the British squadron attending the festivities retained their beautiful colouring of cream funnels and black hulls, the French and German warships, on the other hand, had adopted an obliterative colouring of uniform grey—the shade differing somewhat in the two cases.

During more recent years, holding a consistent belief in the impending war, I continued to interest myself practically in the principles underlying the visibility of ships at sea and the possibility of successful "camouflage." After the outbreak of war, on my return to Glasgow in September, 1914, I proceeded to endeavour to impress upon the Admiralty the conclusions at which I had arrived. These were briefly:—

(1) That while it was not suggested that a ship at sea under average conditions could be rendered *invisible* in the strict sense, yet, on the other hand, it was quite feasible (*a*) to diminish greatly the conspicuousness of a distant ship, and (*b*) to stultify the enemy's range-finders by confusing the details—such as, above all, vertical lines—of which they make use. It is unnecessary to recall that in range-finding as applied to ships at sea there are two factors involved: (*a*) the determination of distance, and (*b*) the determination of the rate and direction of relative movement.

(2) That of the various methods which Nature makes use of in her obliterative colouring of animals there were two alone of practical value for application to ships: (*a*) the contrast colouring already alluded to, and (*b*) the method of compensative shading—the obliteration of relief by counteracting the light and shade to which the appearance of relief in large objects is mainly due. This latter method is simply the application of the great principle of animal coloration which owes its recognition to the distinguished American artist, Mr. Abbott H. Thayer.

I urged upon the Admiralty that, as a protection against long-range gunfire, these two basic principles should be applied to the colouring of ships. The hull and the upper works were, as a preliminary, to be treated on the Thayer principle, dark shadows being lightened and high lights darkened, and then the main protection applied in the form of strongly contrasting pigments, the boundary lines between the colours running uninterruptedly across boats, guns, turrets, etc. Of course, precisely the same principles apply to ships viewed through the periscope of a submarine, but in these early days of the war the submarine menace had not yet become insistent. The main principles outlined above were duly recognised by the Admiralty, one of my letters on the subject written in September being circulated to the Fleet early in November, 1914. Most unfortunately, their carrying into effect was left to the responsibility of the naval officers immediately concerned, without any scientific or artistic supervision. The result was a complete absence of system, and an effect in individual cases calculated to excite, according to one's temperament, derision or tears. In the summer of 1915 I was informed that the principle of parti-colouring had been given up, that the Admiralty had now arrived at a definite decision as to "the most serviceable scheme of colouring for H.M. ships," and that this scheme was one of *uniform* coloration.

I continued to press on the Government—incidentally making myself rather a nuisance to some of my friends—that a system of uniform colouring was *not* the right one, whether applied to ships or to service dress; that of all uniform colours the very worst, whether by day or night, was the black which was then still in use for destroyers, and so on. I also kept on urging that the only way of obtaining really satisfactory results was to place the whole matter of ship "camouflage" under the direction of one individual endowed with practical knowledge of the sea and ships, artistic sense, and grasp of the scientific principles involved.

At last, during the summer of 1917, I had the satisfaction of seeing the principle of parti-colouring come into its own. Discarded by the Admiralty as useless two years before, the value of the principle was now recognised and its application entrusted to skilled hands. Glaring defects which were at first conspicuous were remedied, and the later efforts, such as the great aeroplane-carrier, H.M.S. *Argus*, left little opening for criticism.

The importance of the subsidiary principle—that of compensative shading—as an aid in "camouflage" was, unfortunately, never fully grasped during the course of the war. The distinguished expounder of this principle, Mr. Abbott H. Thayer, was in the strongest sympathy with the cause of the Allies, and I think it a great pity that it was not found possible to enlist his practical help, which I feel sure would have been gladly and freely given.

It is only fair to state, in conclusion, that in my personal communications upon this subject I laid stress upon the use of parti-colouring as a means of rendering ships less conspicuous. I also directed attention to its use in confusing the details, especially vertical lines, which are made use of by the enemy's range-finders, but I did not lay sufficient emphasis on this. Actual experience has shown that in submarine warfare this second function—in particular, determination of the factor of relative movement—is of overwhelming importance. But this does not affect the main point I desire to make, namely, that the leading principle underlying ship "camouflage"—the breaking-up of the form of a vessel by strongly contrasting colours—is one familiar to biologists; that it was made known to the Admiralty in the early days of the war, although its carrying into practice was, unfortunately, bungled; and that consequently newspaper paragraphs which date the discovery of the principle, instead of the more efficient application of it, from the year 1917 are distinctly misleading.

J. GRAHAM KERR.

University of Glasgow, May 6.

A Possible Case of Partial Sterilisation in Soil.

WHEN on active service in France in 1918 I had, partly as a hobby and partly for food supplies, a garden on the site of an old brickyard. The land had been waste land for certainly three years, and I believe more. It received a light dressing of dung in February and was dug up in that month; seeds were got in in March. In April or May the land received by chance a light top-dressing of a mixture of charcoal and brick-earth impregnated with potassium carbonate and hexamethylene tetramine. The crops obtained were, in my opinion, abnormally good, and much better than those obtained by some French gardeners on cultivated gardens near by. The chief crops grown were potatoes, dwarf peas, and dwarf beans; the two last gave the best results in the order named. It is not asserted that the top-dressing brought about this result, as the history of the soil is necessarily rather obscure; and as it was not designed as a scientific experiment there was no control plot, but it seems improbable that the small amounts of nitrogen and potassium supplied by it could have made the garden much better than neighbouring ones.

The suggestion is offered that the hexamethylene tetramine may have liberated formaldehyde by the action of dilute acids in the soil and caused partial sterilisation.

I have since subjected to steam distillation (*a*) a solution of hexamine, (*b*) untreated soil, garden soil, and (*c*) garden soil moistened with hexamine solution. Schiff's reagent gave negative results in the case of (*a*) and (*b*), but positive results with (*c*).

F. KNOWLES.

The Midland Agricultural College,
Kingston, Derby.

MINERAL PRODUCTION IN RELATION TO THE PEACE TREATY.

IT is gradually becoming more and more clear, as the history of the Great War is further examined, that one of the main objects of Germany in attacking her neighbours was commercial aggrandisement by destroying rival manufactories and by appropriating the raw material of industry wherever it lay conveniently situated for that purpose, this raw material being in the first instance all available mineral wealth. She had already done this with supreme success in 1871; the iron-ore fields of Lorraine then wrested from France had formed one of the mainstays of Germany's industrial development, and she fully expected that the new war would yield proportionately valuable results. This was Germany's avowed policy; in the words of one of the acknowledged German authorities, Frederick Naumann, the object of a country nowadays in going to war is purely "to benefit the economic development of the country," and German writers have ever since the commencement of the war announced their fixed determination to retain in German possession the iron-ore fields of French Lorraine, thus giving Germany "the practical monopoly of iron-ore in Europe," and assuring her of victory in the future wars to which she was already looking forward.

Until the actual boundaries, as roughly defined in Sections II. and III. of the Peace Treaty, have been accurately settled, it is only possible to form a general idea of the extent to which Germany's mineral production will be diminished by the territory of which she is to be deprived. Naturally, the first mineral to be considered is coal. In 1913 Germany produced rather more than 190 million tons of coal, of which about 100 millions came from the Westphalian coalfields, 34 millions from Upper Silesia, and 15 millions from the Saar coalfield. So far as can be seen from the Peace Treaty, Germany is to cede to France the whole of the Saar coalfield in compensation for the destruction of the coalfields of Northern France; seeing that the Pas de Calais district produced in 1913 about 22 million tons of coal, and the Nord district about 8 millions, or approximately double the output of the Saar basin, the compensation thus afforded does not err on the side of liberality. It is therefore to be hoped that under Section VIII. Germany will be compelled to deliver over to France as much coal as will bring the total coal supplies of the latter up to at least her pre-war standard until her northern collieries are again fully equipped and in working order.

It appears certain that a considerable proportion of the Silesian coalfields will be ceded to Poland, though how much is by no means settled as yet. It is important that Poland should have ample coal supplies in order that its industrial development may be free and unhampered by any dependence on its neighbours for this indispensable material. Even were the whole of the Silesian coalfields to pass into Polish hands, Germany would still have an output equal to three-fourths of its pre-war output in bituminous coal alone, whilst if lignite is included in the calculation, as it really should be, the annual output of Germany will only be diminished by about 18 per cent.

The restoration of Alsace-Lorraine to France affects two important deposits of minerals—the iron-ores of Lorraine, and the potash deposits of Alsace. In 1913 Germany produced nearly 36 million tons of iron-ore, of which no fewer than 28½ millions were minette ore, more than 21 million tons being produced in Lorraine. It is to be hoped that in the detail of the clauses under which Germany renounces her treaties with Luxembourg conditions will be included that will favour the delivery of the Luxembourg minette to Belgium rather than to Germany. Few things would do more to restore the great iron industry of Belgium, which Germany set herself to destroy with the most brutal deliberation, than such an arrangement as would give Belgium preferential treatment in the matter of this ore. It will be seen that even without any minette Germany will still have an annual production that could easily be brought up to 10 million tons of iron-ore, or, say, 5 million tons of pig-iron, as against 14 million tons in 1913. This production would be ample for the industrial needs of the German nation, though not for the huge output of munitions of war of all kinds for which so much had been employed in the years preceding 1914, and such a drastic reduction of Germany's output of iron is the best guarantee possible for a world peace, and the easiest and safest means of protecting France from any future attempts of German aggression.

The restoration of Alsace to France implies the shattering of the German monopoly in potash salts, upon which she was relying for forcing other nations to trade with her. To quote from an article in a leading German paper written towards the end of 1917: "The Alsace potash beds are amongst the richest that have ever been found. If these deposits passed into the hands of the enemy, it would be the end of the German monopoly of potash. . . . We need not point out what would follow for our own potash industry and of what a financial weapon the enemy would deprive us" (see *Journ. Soc. Chem. Ind.*, November 15, 1918). In 1913 Germany was producing about 11 million tons of potash salts, containing about 1 million tons of pure potash. The Alsatian deposits are much purer, needing in many cases no refining, and much richer, averaging 22 per cent. of potash, and it is calculated that the entire deposit, as at present known, contains more than 300 million tons of potash, or enough by itself to supply the requirements of the world for many years. So jealous were the older companies that composed the Potash Syndicate of Central Germany of the greater potential value of the Alsace deposits that they allowed the latter only an output equal to 5 per cent. of the total German output. Several companies are, however, operating already in the Alsatian field, and it may be confidently expected that the next few years will see such vigorous developments that all the needs of the Allies can be supplied therefrom. Until this can be done, presumably the Germans will be called upon to supply such potash minerals as we may need; it would probably be better that they should be made to furnish the raw mineral than the purified product; the refining in this country will keep our chemical works busy and provide employment; exporting the raw material will also employ usefully the tonnage taking foodstuffs, etc., to Germany, and prevent the Germans from using those ships for exporting to us competitive articles of manufacture.

This general review of the Peace Treaty so far as it bears upon mineral production shows, therefore, that it has been conceived in no oppressive or illiberal spirit. Restitution to France of the iron and potash deposits taken from her in 1871 is but bare justice; the reparation of the damage done to the French coalfields by the cession of the Saar coal basin is a partial compensation for the injuries inflicted on French industry, and the transfer of the Silesian coalfields to Poland is necessary in order to secure to that nation an independent economic existence. It may be suggested that Belgium is entitled to somewhat more in the way of minerals than it appears to be receiving, but apart from this it is to be hoped that the conditions set out in the Peace Treaty represent the irreducible minimum to which the Allies will agree.

H. LOUIS.

THEORY OF BOWED INSTRUMENTS.[1]

DIFFICULT as the violin may be to play, there are many who play to one who experiments upon it scientifically; and, scarce as the experimentalist may be, the successful theorist is yet scarcer. But we have now before us the first part of an elaborate investigation in which mathematical theory and confirmatory experiments happily alternate. Important and interesting results have already been reached, and others equally so are likely to follow, thus clearing up a number of points which have hitherto been obscure.

Helmholtz was able to show, by his vibration microscope, that the bowed point of a violin string might execute a motion the graph of which is a two-step zig-zag. He also surmised that the forward speed of the bowed place of the string equalled that of the bow when a good tone was obtained. From this experimental two-step zig-zag Helmholtz proceeded to his theory of the well-bowed string.

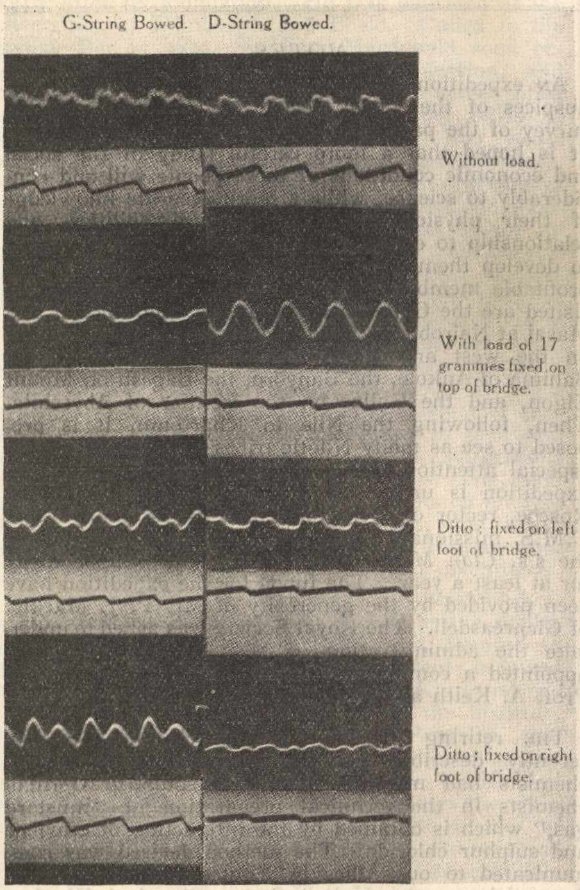

FIG. 1.—Simultaneous vibration-curves illustrating effect of loading the violin bridge on its horizontal motion transverse to the strings (observed at the G-string corner).

F. Krigar-Menzel and A. Raps photographed (upon a film on a revolving drum) various points of bowed strings, and so obtained much information on the subject of the vibrations possible to the strings themselves.

Prof. E. H. Barton and his students took simultaneous photographs of the behaviour of the strings and of the bridge, belly, or air of a monochord and of a violin. But in none of the foregoing cases was a direct *mechanical theory* of the string, bridge, etc., attempted. This has now been accomplished by Prof. C. V. Raman.

The equations of motion of the string are written and solved for the case of a periodic transverse force applied by the bow at a given position. The equations of motion of the bridge are next written and dealt with. Then follow photographs of simultaneous vibration-curves of belly and G-string of a violoncello at the "wolf-note" pitch, showing cyclical changes of amplitude. The *modus operandi* of the bow is next examined, and a simplified kinematical theory of the bowed string based upon it. This leads to a number of types of vibration: two-step, three-step, etc., zig-zag motions appearing in the corresponding graphs.

Another very interesting subject is that of the effect of the *mute*, which, by loading the bridge, enfeebles and veils the tone of the instrument. To investigate this effect, loads were placed in different positions on the bridge of a violin, and simultaneous vibration-curves of string and bridge taken. The results for the G-string and D-string are here reproduced (Fig. 1), the dark zig-zag line on light ground giving the displacement-time graph of the string, the light wavy line on black ground being the graph of the bridge's horizontal motion transverse to the string. Similar results were obtained for the other two strings.

Other points dealt with in the present instalment of the investigation are the effects of the variation of pressure and velocity of bowing, the relation between pressure and speed, and the vibrations obtained from a 'cello when played pizzicato.

The paper contains twenty-eight text figures and twenty-six full-page photographic reproductions, many of them of distinct beauty and instructiveness. All these should be consulted in the original by those interested. Indeed, the entire work well deserves careful study, presenting, as it does, a valuable contribution on the subject of bowed instruments.

[1] "On the Mechanical Theory of the Vibrations of Bowed Strings and of Musical Instruments of the Violin Family, with Experimental Verification of the Results." Part i. By C. V. Raman. (Bulletin No. 15.) Pp. iii+158. (Calcutta: The Indian Association for the Cultivation of Science, 1918.) Price 3*s*. 4*d*.

STATISTICS OF SYNTHETIC DYES.

IT was pointed out, in an article in NATURE for November 21, 1918, that one of the first things which ought to be done in efforts to resuscitate the dye industry in Great Britain is to survey the whole field of dyes and intermediate compounds, so as to determine the source of supply, to ascertain more precisely the needs of the community, both for home purposes and for export trade, to concentrate attention on the production of indispensable colours, and to prevent waste of energy and material on the manufacture of the less important of these products. We now learn from a report issued by the Commissioner for Dyes (Sir Evan D. Jones) that an attempt in this direction was made so early as September, 1914, by a committee of the Society of Dyers and Colourists. This attempt, however, was not successful in securing the information so desirable in the interests of both manufacturers and users.

Nothing further was done until 1916, when an influential committee was formed, and, after a number of meetings at the Board of Trade, a list of the necessary dyestuffs was drawn up. The committee was at that time unable to make any progress in allocating the manufacture of these dyestuffs among British manufacturers. Many changes have, however, taken place since that time, and such movements as the amalgamation of Levinstein's with "British Dyes" is a step which must have facilitated progress towards this very desirable understanding among manufacturers. On the appointment of the Commissioner in June, 1917, a renewed effort was made to compile a census, and, with the assistance of Mr. W. E. Kay, representing the Calico Printers' Association, Ltd.; Mr. Christopher Rawson, of the British Cotton and Wool Dyers' Association, Ltd.; Mr. Thorp Whitaker, of the Bradford Dyers' Association, Ltd.; and Mr. Ernest Bentz, of the English Sewing Cotton Co., Ltd., this has now been done.

The report (dated November 1, 1918) shows the quantities of synthetic dyestuffs imported into this country during the year 1913. These statistics have been prepared from returns supplied by the representatives of the importing firms, and agree substantially with the figures for the total imports into this country during that year. The census has been compiled from the dyer's point of view rather than from that of the dye manufacturer, and the dyes have been classified according to their dyeing qualities, and not according to their chemical constitution. The difficulties of classification have been considerable, owing to the variety of distinctive names and the fact that many of the colours are mixtures. The accuracy of the amounts stated varies in certain cases, and as regards some colours the figures understate the actual colour consumption in the country. This necessarily arises from the fact that the list gives the importations for one year only, and more accurate figures could not be secured except by taking the average of a series of years.

The summary shows that in 1913 the total weight of dyestuffs imported amounted to 40,071,368 lb. The great majority came from Germany. Switzerland supplied important, though relatively small, amounts of dyes of all colours. These are, however, not shown in detail, as the facts were supplied in confidence by Swiss manufacturers, and the totals of each class can alone be given.

Section xii. contains an interesting list of intermediate products, such as naphthols, naphthylamines, the nitranilines, phenylglycine, resorcine, etc., which are not dyes, but are necessary to the production of dyes, as well as other products.

It is hoped that the census will serve among other things as a useful guide in estimating the requirements of the colour-using industries, and form a basis for determining the capacity of plant which it may be necessary to erect. In the present census about 10,000 colours are enumerated, but these do not represent nearly so large a number of individual colouring matters.

NOTES.

AN expedition left this country recently, under the auspices of the Royal Society, to make a scientific survey of the pastoral peoples in East Central Africa. It is hoped that a more careful study of the social and economic conditions of these people will add considerably to science, while a more accurate knowledge of their physical conditions, mental abilities, and relationship to each other will enable those concerned to develop them so that they may become useful and profitable members of the Empire. The tribes to be visited are the Gallas near Mombasa, the Kikuyu and Masai at Nairobi, the Ziba and Watuturu near Bukoba on the west and south-west of Lake Victoria, the Bahima of Ankole, the Banyoro, the Bagesu on Mount Elgon, and the Gallas on the frontier of Abyssinia. Then, following the Nile to Khartoum, it is proposed to see as many Nilotic tribes as possible, paying especial attention to the Banyuli and Badamu. The expedition is under the direction of the Rev. John Roscoe, rector of Ovington, formerly for many years C.M.S. missionary in Uganda. Mr. Roscoe sailed in the s.s. *Clan Menzie* on April 15, and will be away for at least a year. The funds for the expedition have been provided by the generosity of Mr. P. J. Mackie, of Glenreasdell. The Royal Society was asked to undertake the administration of Mr. Mackie's gift, and appointed a committee to control the expedition with Prof. A. Keith as chairman.

THE retiring president of the Chemical Society recently described to the members how British chemists had managed greatly to outstrip German chemists in the technical preparation of "mustard gas," which is obtained by the interaction of ethylene and sulphur chloride. The method devised was communicated to our Allies in France and in America. An article on the United States Chemical Warfare Service, appearing in the *Scientific American* for March 29, shows what was being done in that country as regards this and other "poison gases" when active hostilities ceased last November. During the winter of 1917–18, as a result of the growing importance of gas warfare and of the representations made by British and French officials, the United States authorities decided to erect a very large chlorine plant. The site selected was largely farm land under cultivation, so that housing accommodation had to be erected and transport facilities provided before a start could be made. By July the chlorine plant, designed to produce 100 tons per day, was ready to deliver chlorine, but the chemical installation for working the gas up was not so far advanced, and did not begin operations until September. Nevertheless, at the close of hostilities the staff had developed the gas-making facilities at such a rate that they could produce more than 100 tons of "poison gas" daily, and, but for the armistice, that quantity would have been doubled by the beginning of the present year. What this would have meant may be understood when it is stated that the total output of "poison gas" from the German factories was only thirty tons per day. Indeed, as regards the "mustard gas" itself, it has been learned since the armistice that the largest daily quantity the enemy could manufacture was from six to eight tons, or only about one-fourth of the amount which the American chemists alone were producing in November.

THE RIGHT HON. SIR JOHN H. A. MACDONALD (Lord Kinsburgh), F.R.S., who died at Edinburgh on May 9 in his eighty-third year, was keenly interested in science, and joined the Institution of Electrical Engineers shortly after its foundation. He was educated at the Universities of Edinburgh and Basle. Called to the Scottish Bar in 1859, Sir John Macdonald soon obtained considerable success in his profession, and during a long and distinguished public career filled many important positions. He held the office of Solicitor-General for Scotland during the years 1876–80, and four years later became Lord Advocate. Whilst holding the latter office he sat in Parliament as Member for Edinburgh and St. Andrews Universities (1885–88), and carried through the House of Commons an Act which introduced considerable reforms in Scottish criminal administration. In 1888 Sir John Macdonald was appointed Lord Justice-Clerk of Scotland and Lord President of the Second Division of the Court of Session, an office which he held until 1915. Early in his career he interested himself actively in the Volunteer Force, and served in it for many years, during which he continuously and persistently strove to bring about reforms in drill and tactics; eventually the majority of his suggestions were adopted by the military authorities. Sir John published numerous books and other works on matters relating to electricity, law, and tactics, and many medals and diplomas were awarded to him in connection with his life-saving and electrical inventions.

A LARGE and distinguished gathering assembled at the Guildhall on the evening of May 8 at the jubilee banquet of the Iron and Steel Institute, founded in 1869. M. Eugène Schneider, the president, occupied the chair, and read messages from the King and the Prince of Wales wishing prosperity to the institute. In proposing the toast of "Peace, Progress, and Prosperity," the president referred to the moral situation of the Allied nations, especially the British and French, who were bearing on their shoulders the main burden of peace. He said that the task of men of good will was made more difficult by short-sighted folk who imagined that they possessed an infallible nostrum, a special device which held in every case and in every circumstance. The mass of French and British working-men, however, instinctively distrusted "day dreams." They looked forward to a satisfactory social order without revolutionary crises and civil wars. Was the task impossible? Some master-builders would be able to rear a new edifice wherein every tenant would find pleasure to live, provided social problems were dealt with by those who were worthy of the title "leaders of men." Discussing the future relations between employers and employed, the president emphasised that these can be satisfactorily brought about only by educating both classes. Future captains of industry must learn to know their own men, and working-men must be able to judge their employers otherwise than by hearsay. Future engineers must include in their training a few months' probation in the workshops as ordinary working-men, and not lose the benefit of mingling with them.

THE U.S. National Academy of Sciences held a very successful annual meeting at Washington on April 28–30. Many of the subjects discussed dealt with the war, while other papers presented recent developments in pure and applied science. The academy is the scientific adviser of the United States Government, co-operating with the different Departments and Bureaux in the execution of the more practical developments. Another function is the representation of the United States by academy members in international affairs, some of the members having served as foreign scientific attachés in Europe during the war. The most important of the allied branches of the academy is the National Research Council, which body has carried on some very valuable work for the War and Navy Departments, particularly relating to submarine defence, nitrate supply, radio communication, ordnance, wireless control, searchlights, etc., features of which were described during the recent meeting. At the annual dinner of the academy, held on April 29, gold medals were presented to Prince Albert of Monaco and Prof. Charles Fabry, of the University of Marseilles, for their contributions to the advance of science. Dr. Charles D. Walcott, president of the academy, made the presentations. The award of the Henry Draper gold medal to Prof. Fabry was made for his notable investigations in the science of astronomical physics, particularly his researches in connection with the light of the sun and other astral bodies; while the original contributions of Prince Albert of Monaco on oceanography received the highest recognition of the academy in the form of the Alexander Agassiz gold medal, established through funds provided by Sir John Murray. This is the second award of the Agassiz medal, the first having been presented to Dr. Johan Hjort, of Bergen.

A NEW American Arctic expedition proposes to start in a few weeks to explore the untraversed part of the Arctic Ocean between Bering Strait and the North Pole. The expedition, which was postponed a few years ago, is to be under the leadership of Capt. R. A. Bartlett, and will be supported by the Aero Club of America. The *Geographical Review* for March (vol. vii., No. 3) gives some details of the plans. Flying bases are to be established at Cape Columbia on Grant Land, at Cape Chelyuskin in Siberia or on Nicholas Land to the north of it, and at Wrangel Island. The expedition will have a large aeroplane capable of making the flight of more than 1100 miles from Cape Chelyuskin to the Pole, and several smaller aeroplanes for shorter flights. The main base of the expedition will be at Etah, in Greenland. In addition to the vessels required to establish the bases, it is proposed to send a small vessel through Bering Strait and force her into the pack in the hope that she will drift across to the European side of the Arctic Ocean, thus emulating Capt. R. Amundsen in his expedition now in progress. Capt. Bartlett's expedition is planned to take three years.

IN spite of the chaotic conditions in Russia, a new hydrographical expedition to the seas north of Siberia is being planned by the Russian Hydrographical Department. From *La Géographie* (vol. xxxii., No. 4) we learn that the expedition will be divided into two parts: one under Comdr. Vilkitski will work between the White Sea and Cape Chelyuskin, the other under Comdr. Novopashenni between Cape Chelyuskin and Bering Strait. The coasts are to be surveyed, coastal waters sounded, and ice conditions studied throughout a whole year. It is also proposed to set up several meteorological stations fitted with wireless telegraphy. The sites suggested are at White Island (off Yamal), the north of Novaya Zemlya, Obdorsk, Cape Chelyuskin, the mouths of the Lena and the Kolima, the

New Siberia Islands, and Koliuchin Island. These stations will co-operate with those already existing at Yugor Strait, Cape Mare Sale (Yamal), and Dickson Island (Yenisei). Attention is to be paid to economic conditions and the possibilities of trade.

SIR EDWARD SHARPEY SCHAFER writes that the remarks made in a note in NATURE of May 1, p. 173, with reference to his address on "The Position of Physiology in Medicine" is apt to give the impression that he would favour a plan of allowing the student to see something of hospital work at the commencement of his course. We regret the possibility of this misunderstanding. The suggestion was made as an attempt to remedy the admitted difficulty of convincing the student of the value of physiology. Sir Edward Sharpey Schafer, on the contrary, contends that it is a positive disadvantage to give any premature attention to clinical medicine and surgery; and that it is not only useless for understanding these subjects, but also fatal to the attainment of a proper grasp of physiology, which must, in the first instance, be studied as a pure science. We are glad to have the opportunity of making his position clear.

PROF. G. ELLIOT SMITH has been elected president of the Manchester Literary and Philosophical Society.

THE ninth annual May lecture of the Institute of Metals will be delivered by Prof. F. Soddy on "Radioactivity," at Caxton Hall, Caxton Street, Westminster, on Monday, May 19, at 8 p.m.

SIR NAPIER SHAW has resumed the administrative duties of the directorship of the Meteorological Office, from which he was relieved in May of last year by the appointment of Col. H. G. Lyons to be acting director for the period of the war.

IN connection with the fifty-sixth annual meeting of the British Pharmaceutical Conference, which is to be held in London on July 21–24 inclusive, there is to be a memorial lecture as a tribute to the memory of the late Lt.-Col. E. F. Harrison.

WE are asked to state that, in compliance with a suggestion by the Ministry of Labour, Appointments Department, the library and reading-room of the Society of Engineers (Incorporated), 17 Victoria Street, Westminster, S.W.1, have been placed at the disposal of officers at present looking out for appointments in the engineering and allied professions. All such officers are also cordially invited to attend the ordinary meetings of the society, particulars of which may be obtained on application to the secretary.

DR. FERDINAND G. WIECHMANN died recently in New York at the age of sixty. He was an instructor in chemistry at Columbia University from 1883 to 1897, since which time he had been mainly occupied as a consulting research chemist. He was a specialist in the chemistry of sugar, and had written largely on that subject.

THE Smithsonian Institution at Washington has announced that the studies carried on at Calama, in Chile, and Mount Wilson, in California, with regard to solar radiation and its effect on weather conditions have proved so satisfactory that it contemplates establishing three or four additional observing stations in widely separated and almost cloudless regions, such as Egypt, India, South Africa, and Australia. It is reported that the weather forecasts of the Government of Argentina are now based on observations made at the Calama station.

THE death is announced, in his eighty-sixth year, of Prof. Charles Brinckerhoff Richards, who was professor of mechanical engineering at Yale from 1884 to 1909. Prof. Richards was frequently called upon by the American Government as an expert adviser, and in 1889 was U.S. Commissioner to the Paris Exposition to report on all mechanical exhibits. He was made a Chevalier of the Legion of Honour for his invention of the Richards steam-engine indicator. Prof. Richards edited the engineering and other technical words in Webster's International Dictionary.

BY the death of Mr. G. M. Apsey on May 3 the Admiralty loses one of its most faithful servants, and the Royal Corps of Naval Constructors one of its best-known and valued officers. A summary of Mr. Apsey's career is given in *Engineering* for May 9. He entered Sheerness Dockyard in 1877, and became a student at the Royal Naval College, Greenwich, in 1882. He was inspecting officer for torpedo-boat destroyers from 1895 to 1902, and became chief constructor at Gibraltar in 1913. He also served at Rosyth and Portsmouth, and joined the Department of the Director of Dockyards in July, 1916. He was in his fifty-sixth year at the time of his death.

THE North-East Coast Institution of Engineers and Shipbuilders is to hold a summer meeting at Newcastle-on-Tyne on July 9–11. The following papers have been arranged for:—"Women's Work in Engineering and Shipbuilding during the War," the Hon. Lady Parsons; "Shipbuilding and Marine Engineering done on the North-East Coast during the War," E. L. Orde; "Aviation during the War, and its Possible Future," Lord Weir; "Dazzling of Ships," Lt.-Comdr. Wilkinson; "Limits of Thermal Efficiency in Diesel and other Internal-combustion Engines," Sir Dugald Clerk; "Ship-repairing during the War," M. C. James and L. E. Smith; "Transmission of Power," G. Constantinesco; and a lecture by Prof. J. C. McLennan.

THE Home Secretary has appointed a Committee to inquire and report on possible improvements in miners' lamps as regards safety and illumination and alterations which may be desirable in the present methods of testing and approving such lamps for the purposes of Section 33 of the Coal Mines Act, 1911. The Committee consists of Mr. W. Walker (chairman), Prof. F. Edwin Armstrong, Mr. T. G. Davies, Mr. V. Hartshorn, M.P., Mr. G. A. Mitcheson, Mr. S. Roebuck, Mr. J. Wallwork, and Dr. R. V. Wheeler, Director of the Home Office Experimental Station at Eskmeals. Mr. E. G. Fudge is the secretary, and communications on the subject should be addressed to him at the Home Office, Whitehall, S.W.1.

ARCHÆOLOGISTS will welcome the appearance in *L'Anthropologie* (vol. xxix., Nos. 1–2) of another instalment of L'Abbé H. Breuil's valuable accounts of paintings in Spanish caves. He now deals with discoveries made in 1909 in the valley of Bateucas, Salamanca. If these drawings in artistic skill fall short of those already discovered at Altamira, Marsoulas, or La Mourthe, they still possess much interest, including rude figures of human beings, animals, and fish. The question of the age of these paintings is still under discussion, but M. Breuil remarks that it seems difficult to assign the Bateucas frescoes to the Neolithic age in the apparent absence of any monument or object in the vicinity characteristic of that period.

IN the *Quarterly Review* for April Dr. R. R. Marett, taking as his text Sir James Frazer's "Folk-lore in the Old Testament," discusses the current modes of interpreting folk-beliefs, and suggests a method more in accordance with the psychology of the folk.

Hitherto folk-lore has been defined as "the study of survivals, a palaeontology of human culture," whereas the new philosophy treats it, "not as so much dead matter, but as the outcome of an organic process, namely, of an existing or recently existing folk-life." Despite the vast mass of detailed evidence that lies ready to hand, there has never been attempted a comprehensive description of the mental life of the folk at our doors, much less a general analysis that makes out how and why it is so markedly gregarious in its distinctive manifestations. In other words, tradition must be treated as the live expression of the collective consciousness. And in considering the material we must make due allowance for the fact that lack of meaning may or may not imply loss of meaning. This important paper deserves the attention of all students of popular beliefs.

MR. J. H. GURNEY'S "Ornithological Notes from Norfolk for 1918," in *British Birds* for April, make good reading, for, among other things, he tells us that there is good reason to believe that as many as six pairs of bitterns bred in Norfolk during the spring and summer of 1918. At least five out of these six were reared successfully. The great crested grebe, the gadwall, the shoveller, and the bearded tit are also on the increase as the result of the jealous protection now extended over the area of the Broads district.

WE have received the report of the Director-General of Public Health, New South Wales, for the year ended December 31, 1916. It contains a mass of statistical and other matter concerning the health of the State. It is of interest that the minimal legal standard adopted for the fat in milk is 3·2 per cent., ours being only 3 per cent. As regards research work, a record has been kept of the number and seasonal prevalence of fleas on rats, and an extended investigation has been carried out on dengue fever in Australia—its transmission by certain mosquitoes, the presence of a filterable virus in the disease, and observations on immunity, length of the incubation period, and other clinical features.

THE land planarians of Ceylon have been the subject of considerable attention, but those of India have hitherto been almost entirely neglected, so that records of the latter are rare, incomplete, and uncertain. Prof. R. H. Whitehouse has published (Records Indian Museum, vol. xvi., part 1, January, 1919) a systematic account of Indian land planarians based on specimens in the Indian Museum. Of the seventeen species recorded in this paper, ten (five described as new) belong to the well-known genus Bipalium, five (four new) to Pelmatoplana, and one to each of the genera Dolichoplana and Cotyloplana.

DR. A. G. MAYOR'S report on the Department of Marine Biology of the Carnegie Institution of Washington for the year 1916, which has only recently reached us, contains a record of much work of interest to marine biologists. During a month's stay on the Island of Tobago Dr. Th. Mortensen was able to study the larval development of ten West Indian Echinoderms, the larvæ in several cases being reared through the metamorphosis. The physical conditions at Tobago are described as being unusually good for work of this character. Dr. H. Lyman Clark also describes the location of the Tobago laboratory as being an ideal one for Echinoderm studies. Mr. L. R. Cary gives an account of his studies on the physiology of the nervous system of Cassiopea, and Dr. A. J. Goldfarb describes experiments on the ageing and death of germ-cells, the eggs and sperm of the sea-urchin, *Toxopneustes variegatus*, having been used for the experiments.

Two translations lately received from Sir Robert Hadfield refer to recent developments in Germany. One of these is entitled "The Union of Technical Men," the inaugural meeting of which was held in Berlin fourteen days after the signing of the armistice. Its chief object is to ensure that technologists may bring their influence to bear on the Government, Parliament, and the economic life of the country. To attain this object an endeavour will be made to bring representatives of all branches of technical practice, from the foreman to the technical chief, into one comprehensive organisation. More than two thousand technical men attended the inaugural meeting, and papers were read by Siegfried Hartmann and Engineer Genest. The other document is a translation of an address by Herr Krupp von Bohlen on "Co-operation and Profit-sharing." In this address the lecturer dealt with a number of problems relating to the cooperation of workers in the undertaking and profit-sharing, and intimated that many changes would have to be made in the firm to keep pace with the present trend of the times with a view to continued development on sound lines.

IN a paper read before the Washington Academy of Sciences in June, which is reproduced in the Monthly Weather Review of the United States Weather Bureau for October, Prof. W. S. Franklin, of the Massachusetts Institute of Technology, directs attention to a much-needed change of emphasis in meteorological research. Hitherto it has mostly been occupied too exclusively in averaging large collections of observations, when a more detailed study of the movements of individual storms, and the determination of the correlation between storms of the same type on successive days, would be of much greater service in weather prediction. Prof. Franklin believes that such an intensive study of weather conditions would establish the conclusion that at certain critical times in the life-history of a storm the expenditure of a very moderate amount of energy would enable the subsequent movement of the storm to be controlled.

THE following books of scientific interest are announced for publication in the near future:—"The School Gardener," J. Norris (*Cassell and Co., Ltd.*); "Psycho-Analysis and its Place in Life," M. K. Bradby (*Henry Frowde and Hodder and Stoughton*); "Universitatum et Eminentium Scholarum Index Generalis: Annuaire Général des Universités (The Year-book of the Universities)," Prof. R. de Montessus de Ballore (*Paris: Gauthier-Villars et Cie*); a translation, by Teixeira de Mattos, of another volume by Fabre, to be called "The Sacred Beetle" (*Hodder and Stoughton*); "Bird Behaviour," F. Finn, and "Insect Artisans and their Work," E. Step, both in the Nature Library (*Hutchinson and Co.*); "Telephonic Transmission, Theoretical and Applied," J. G. Hill; "Currency and Credit," R. G. Hawtrey; and a new edition—the fourth—of "The Principles of Electric-wave Telegraphy and Telephony," Prof. J. A. Fleming (*Longmans and Co.*).

THE latest Catalogue (No. 178) of Messrs. W. Heffer and Sons, Ltd., Cambridge, possesses a sentimental as well as a scientific value, seeing that it contains selections from the libraries of the late Canon Merle Norman and the late Sir William H. Preece. It should be of especial interest and use to readers of NATURE, being devoted entirely to books relating to science. Some 1300 works are listed under the following headings:—Agriculture and Husbandry, Anthropology and Ethnology, Botany, Chemistry, Geology, Mineralogy, and Palæontology, Zoology and Biology, Physiology, Anatomy, and Medicine, with the subsection of Dentistry, Mathematics and Physics, Astronomy, and Engineering. The catalogue is strong in books published in Germany, and therefore not easily procurable at the present time. An interesting item offered for sale is a collection of about eight hundred pamphlets dealing mainly with genetics and variation, formed by the late J. R. Gregory, of the University of Cambridge. Messrs. Heffer have also for disposal a complete set of the Reports of the Scientific Results of the *Challenger* Expedition, with letters by Sir C. Wyville Thomson, Sir John Murray, and Sir George S. Nares inserted.

OUR ASTRONOMICAL COLUMN.

COMING CONJUNCTIONS.—The planets Venus and Jupiter, which are now conspicuous objects in the evening sky, will be in conjunction in right ascension on May 25, Venus being 2° 7′ N. in declination. The moon, which will be new an hour after noon on May 29, will be in conjunction with Jupiter in the early morning of June 1, and with Venus in the evening of the same day, and the picture presented by the young moon and the two planets in the evenings of May 31 and June 1 may be of interest, though the conjunctions are not close. Venus will make close conjunction with Saturn on July 2, when the distance between the two objects will be only 10′. The appearance of these three planets so near together in the evening sky is noteworthy.

MARS.—A memoir on Mars from the pen of Mr. Harold Thomson, president of the British Astronomical Association, appears in *Scientia* for May. Mr. Thomson narrates concisely the facts known about the planet from observation, and takes the very proper view that it is not specially the function of the astronomer to indulge in speculations as to the possibility of inhabitants of other worlds based on such facts, but only to collect them. Nevertheless, he makes the point that the changes in the form of the dark markings and in their positions may represent changes on the surface of the planet which have analogies on our earth in the destruction of large forest areas, the ploughing up of vast tracts of land, or the changes caused by the operations of husbandry, and this may supply arguments to those who assert the existence of intelligent beings on Mars of as great weight as those furnished by the canals. The author gives no definitive opinion of his own on the question, but suggests that further observation may lead to substantial increase in our knowledge of the physical conditions of the planet.

AVIATION AND WEATHER.

ATLANTIC flying is steadily increasing in interest with the delay occasioned by the weather and by the increase in the number of competitors with the lapse of time. If any season of the year is favourable to a westerly flight it is the spring, and certainly just at present the prevailing east winds over the Atlantic near the surface of the sea would, in a measure, encourage the aspirants for a flight from the British Isles westwards. St. John's, Newfoundland, is evidently a badly chosen spot for a start on an easterly flight, if only for the reason that should a start be made the prevailing fogs would not allow of a safe return if for any reason a return is necessary. In a westerly flight from the European side certain localities must be avoided for landing, due to the well-known prevalence of fog. The shoal-water in the neighbourhood of St. John's is evidently an important factor in the formation of fog, and with easterly winds fogs seem to be much intensified. The United States naval seaplanes have accomplished their first stages as far as Newfoundland satisfactorily, but the next stage to the Azores is a more severe test. Adverse winds would materially hamper their flight, and at present it scarcely seems that contrary winds can be avoided on a part at least of the route to be chosen. American warships are stationed between Newfoundland and the Azores at such distances apart as must afford considerable confidence to those engaged in the flight. The brightness of the moon just now will be an additional advantage if winds and weather promise to be favourable.

Flight from England to Australia is now becoming as enticing to pilots of aircraft as the Atlantic flight. The *Times* of May 12 announces that "the preliminary conditions of the Australian Government's offer of a 10,000*l.* prize for the first Australian airman to fly from Great Britain to the Commonwealth have been arranged at a conference attended by representatives of Mr. Andrew Fisher, High Commissioner for Australia in London, the Royal Aero Club, and the Air Ministry." It is stipulated that the prize must be won before the close of 1920. The distance must be completed in 720 hours, and a disabled machine must not be towed more than 100 miles, and not more than twenty miles at one time. The probable route will include, amongst other places, Paris, Rome, Bagdad, Calcutta, Singapore, Batavia, and Port Darwin. There is plenty of work for meteorologists at present to decide the most favourable passage for aeronauts engaged in commercial aircraft traffic, and this second prize for a long route will require much thought and calculation. A good deal is known with regard to the winds near the earth's surface, but for a large portion of the route little has been ascertained as to the direction and velocity of the upper air.

Flying and the weather at sea by wireless reports from ships is dealt with by the Admiralty in a "Notice to Mariners" (No. 880, 1919). Arrangements are being made for the regular supply of information three times a day, at 1 a.m., 7 a.m., and 1 p.m., Greenwich mean time, when vessels are within a certain distance of stations being established in the north-eastern Atlantic. It is proposed to collect weather information by wireless from ships at sea all over the world, and it is hoped that the information received will be of use for the requirements of aircraft and admit of ships being supplied with trustworthy weather reports and forecasts wherever they may be. Much of the success of the undertaking depends on the rapidity of passing such data by wireless from the ship to the coast station and on to the Weather Office. Ships not supplying data are asked to exercise care not to interfere with the transmission of the wireless messages to the shore. At present the scheme is undertaken by the British Meteorological Office, and revision of the scheme will necessarily be made from time to time. It is proposed that ships communicating the weather information should send out a warning which is designed to notify ships within range that a report is about to be made, and that they should therefore avoid interfering. A wireless weather bulletin issued to ships may take the form of an official weather report giving the existing weather conditions, or an official weather forecast giving the probable future weather conditions. The "Notice to Mariners" will necessarily be studied by all vessels interested in the weather advance proposed.

FUEL ECONOMY.[1]

EVERY nation which joined in the war suddenly found its productive man-power reduced while the productive capacity of the country had to be increased. Questions of economy, which used to be considered from a money point of view, now appeared in their true aspect as being quantity problems. It was not easy to discard the old methods, especially at a time when attention had to be riveted on the many new subjects which arose out of the war, and the University of Illinois is to be congratulated on having drawn up a set of most useful instructions as to how fuel economy, from the quantitative point of view, can be effected without even mentioning the saving in costs. The committee which drew up the instructions had the assistance of an advisory committee, which included railway engineers and representatives of locomotive engineers and firemen, and it would almost seem as if their influence had had the salutary effect of toning down scientific truths to a level where they could be understood by firemen.

The nearest approach to what might be called science

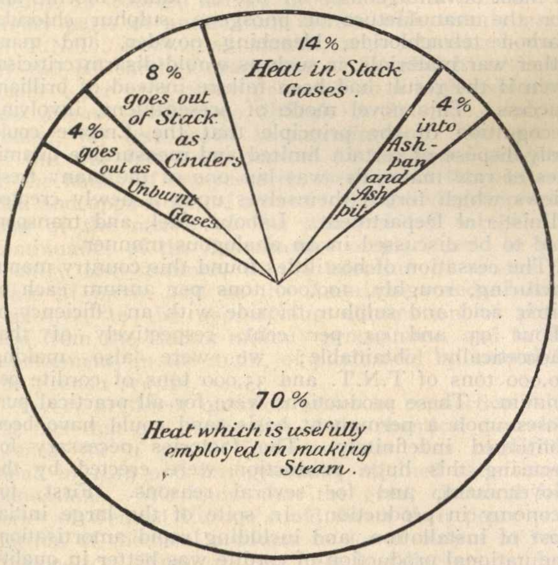

FIG. 1.

is a set of diagrams illustrative of heat or energy losses. The first, which, slightly modified, is shown in Fig. 1, deals only with the steam-raising losses in properly worked locomotives burning good American coal. The second diagram is a coloured locomotive overlaid with energy streams, which, in addition to the information contained in the first diagram, shows what becomes of the energy contained in the steam. Five per cent. is lost by radiation, 6 per cent. is used for auxiliary purposes, 52 per cent. escapes with the exhaust steam, and only 6 per cent. of energy is converted into useful work at the drawbar.

The Bulletin then proceeds to deal with these various losses and to explain how engineers and firemen can reduce them, the firing instructions being beautifully illustrated, but the committee does not stop there; it shows how coal is wasted before it reaches the locomotive both during transport and when stored, for, so it appears, American coal-dumps seem to take fire fairly frequently. Railway officials, from signalmen to repair works managers, are also told that they cause a lot of waste, for it is estimated that 20 per cent. of fuel is burnt by a locomotive while raising steam and while waiting for a job, or on the road when the signals are against it.

In view of our present shortage of coal, it would be very desirable that this Bulletin should be widely circulated in this country, not only amongst railwaymen, who are, of course, chiefly interested, but also amongst the general public, who with its help would gain some insight into the complexity of railway management. This will be all the more desirable if the State purchase of railways is to be carried out.

The paper contains some interesting statistics about American coal, from which we learn that 22 per cent. (150,000,000 tons) is consumed in locomotives for hauling purposes alone, which is a little more than one ton per head of population. Unfortunately, only 6 per cent. of these 150,000,000 tons are doing useful work. Doubtless, from a money-making point of view, this enormous loss of 94 per cent. cannot be materially reduced, but from a national point of view encouragement should be given to quantitative saving in order to prolong the time during which our coal resources may remain at our disposal.

[1] "The Economic Use of Coal in Railway Locomotives." University of Illinois Bulletin, vol. xvi., No. 2, 1918.

THE EFFICIENCY OF INVENTIONS.

A PAPER entitled "Efficient Invention," with special reference to patents affected by the war, was read before the Institution of Automobile Engineers by Mr. Douglas Leechman on February 5. The author recommends the Government to secure the confidence of the inventor by understanding, appreciating, and encouraging him. It is further suggested that (1) the present surplus of 100,000*l.* a year between the receipts and expenditure of the Patent Office should be surrendered to the inventor by way of reductions in the renewal fees payable on patents, and (2) the period of protection lost owing to the war should be added to the term of the patents affected. A proposal is also made that all patents which have expired since August 4, 1914, should be restored for a period equal to the duration of the war. Mr. Leechman states that the efficiency of inventions from the point of view of the patentee depends upon (1) the nature of the invention, (2) the capabilities of the inventor and his opportunities for working or placing the invention, (3) the way in which the invention is received, and (4) the law relating to inventions. He comments upon each of these matters, and expresses the opinion that the average inventor is lacking in the commercial instinct. A recommendation is made that some business experience should be included in the instruction given to inventors. Sound advice is also offered with regard to the steps which should be taken when inventions are being placed on the market and in connection with dealings with licensees. It may be doubted whether Mr. Leechman's proposal to restore indiscriminately all patents which expired during the war would either achieve the end desired or even prove tolerably satisfactory; its adoption would certainly prejudicially affect many persons who have legitimately embarked upon the manufacture of the articles the expired patents of which it is proposed to revive. A more equitable method of dealing with the patentees who have suffered exceptional hardship owing to the decision of the Government to concentrate the energies of the country on the production of munitions would be to ascertain the probable extent of the loss in each particular case, and to provide compensation accordingly out of a fund voted by Parliament for this purpose.

European war + science

CHEMISTRY IN THE NATIONAL SERVICE.[1]

SINCE the autumn of 1914 a great change has taken place in the public attitude towards the natural sciences, and towards chemistry in particular. One of the recognised duties of the spokesmen of science during the past sixty years or more has been that of endeavouring to bring home to the general public and to its administrators the danger of neglecting the cultivation of pure and applied science. The eloquent discourses of our predecessors, Lyon Playfair, Roscoe, Meldola, and the veterans happily still with us, Tilden and Armstrong, all past-presidents of our society, on the national importance of chemistry are well known to all of us, but we cannot claim that these utterances produced an effect compatible with their gravity.

Recent events have, however, given a stimulus to the popular appreciation of the need for wider application to scientific investigation of all kinds which is incomparably greater than had been excited by the previous half-century of the spoken and written word. It may be useful at the present time to consider a few of the causes for this change in public opinion, partly because of the clarification of ideas which emerges from free discussion, partly because of the desirability of recording certain facts and particulars which may be of value to future historians of the strenuous period now ending and giving place to another still more strenuous.

At this time four years ago an urgent call was made for the services in a military capacity of all the chemists who could be spared from civil life. Large numbers were taken into the Army, and formed the nucleus of the magnificent Gas Warfare Service which has been slowly but efficiently developed. Many of these colleagues of ours are now returning to their legitimate spheres in the industrial and scientific life of the Empire, but many will not return; among those who have fallen I would refer more particularly to one who was well known to most present for the invaluable services which he rendered on the defensive side of chemical warfare. Lt.-Col. Harrison was one of the great discoveries of the war, and his death on the eve of the armistice was one of its many great tragedies; the protection against gas-poisoning which has been employed by our own and Allied troops, a protection far more efficient than that ensured by the devices elaborated at leisure by the Central Powers, was due mainly to his wide knowledge, great organising ability, and unfailing resourcefulness in emergency. A movement for the establishment of a memorial to Col. Harrison was set on foot by the Chemical Warfare Committee, of which he was the Controller at the time of his death, and a considerable sum has been collected from those who had been associated with him in his work for the Services. The Chemical Warfare Committee has approached the council of the Chemical Society, and has offered, under certain conditions, to place a memorial tablet or other suitable permanent memorial in these rooms, and also, under certain further conditions, to establish a trust fund to be held by the society. The council has with great pleasure intimated its willingness to accept these gifts, and one of the first duties of your new council will be to decide how best to carry out the provisions of the trust deed.

The efficiency of the British gas protection, which called for the exhibition of so much scientific skill both in research and in manufacture, and led to its adoption by our Allies, is one striking illustration of the paramount importance of science which has appealed to the general public. This subject is, however, but a small branch of the enormous chemical problem which presented itself to the nation nearly five years ago, and led to the organisation under Lord Moulton of the Department of Explosives Supplies. During the working out of this problem issues presented themselves which are probably dissimilar from any which have ever arisen before.

Thus, as the magnitude of the struggle became gradually obvious, it was realised that the whole of the resources of the Empire would have to be utilised fully if success was to be attained. A census of all available chemical products had to be taken and schemes for their exploitation laid down; all materials had to be apportioned out in accordance with the principle that whatever was used for the manufacture of one particular war material left a corresponding shortage of raw material in connection with the manufacture of some other, and perhaps equally essential, product. The intricacy of gauging the chlorine output of the country, of determining how to increase it at the maximum rate without unduly disturbing other interests, of apportioning it most advantageously for use as liquid chlorine and for the manufacture of phosgene, sulphur chloride, carbon tetrachloride, bleaching powder, and many other war materials, is such as would disarm criticism even if the result had been failure instead of brilliant success. This novel mode of presentment, involving recognition of the principle that the Empire could only dispose of certain limited and measurable quantities of raw materials, was but one of the many fresh views which forced themselves upon a newly created Ministerial Department. Labour, fuel, and transport had to be discussed in an analogous manner.

The cessation of hostilities found this country manufacturing, roughly, 100,000 tons per annum each of nitric acid and sulphur trioxide with an efficiency of about 93 and 91 per cent. respectively of that theoretically obtainable; we were also making 60,000 tons of T.N.T. and 35,000 tons of cordite per annum. These productions were for all practical purposes upon a permanent basis, and could have been continued indefinitely. The factories necessary for securing this huge production were erected by the Government, and for several reasons. First, for economy in production. In spite of the large initial cost of installation, and including rapid amortisation, the national production of cordite was better in quality than, and of approximately one-half the cost of, that imported from America. Secondly, for certainty of supply, which could be ensured only by a home production not subject to the risks of oversea transport.

With this necessity for gigantic production the urgency for economy in manufacture necessarily went hand in hand. One of the most interesting documents of the war is the second report on costs and efficiencies for H.M. factories controlled by the Department of Explosives Supplies, which has been recently issued. This report contains a minute analysis of the working costs for each period of each factory engaged upon individual items of manufacture; it states what proportion of the cost per ton of product is borne by labour, raw materials, fuel, maintenance, etc., and provides an incitement to further effort towards economy of working by giving a "bogey" cost-sheet made up of the most efficient details of cost selected from the complete analysis of expenses. It will be clear that an immense amount of organising power was required to achieve this stupendous result; it was due largely to the genius and energy of Mr. K. B. Quinan.

It must be remembered, however, that this permanent memorial to British chemical activity in production was rendered possible only by the intense

[1] Presidential address delivered to the Chemical Society on March 27 by Sir William J. Pope, K.B.E., F.R.S.

effort of the army of chemists and engineers enlisted under the command of Lord Moulton. The necessity for utilising all the chemical resources of the country to the utmost led, in direct relationship with the census of raw materials previously mentioned, to the attempt to extract the last possible fraction of efficiency in each component process. The huge production just indicated made it very profitable to carry out a vast amount of careful scientific investigation of details of manufacture; so many fellows of this society devoted their best efforts to this work that it would be invidious to mention names. Our colleagues have had ample opportunity to realise that the romance of war is now to be found in the laboratory, the workshop, and the factory quite as much as on the battlefield.

An instructive example of the operations of the struggle for economy in the production of a given effect is found in the rivalry which arose between picric acid and ammonium nitrate for use as high explosives. Picric acid costs about 185*l.* per ton to make, ammonium nitrate about 50*l.*, and T.N.T. about 100*l.* per ton; the high cost of picric acid means, of course, limited production. A mixture of eighty parts of ammonium nitrate with twenty parts of T.N.T., known as amatol, was introduced early by the Research Department at Woolwich as being about 5 per cent. more powerful as a high explosive, less *brisant*, and more difficult to detonate, and, of course, far less costly to manufacture. The course of the war has been marked by continued progress at the hands of our research chemists in the preparation and application of amatol; the growing appreciation of the merits of this material led to the discontinuance of the manufacture of picric acid in this country last summer, to the adoption of amatol in place of picric acid as the American standard high explosive, to the approaching elimination of picric acid from the Italian military programme, and to the replacement, in the main, of picric acid by amatol in the French service.

A very pertinent question arises in connection with the fact that our production of the chemical materials needed for a great European war was negligibly small in 1914 and has gradually attained satisfactory dimensions. We know that the great chemical factories of Central Europe could divert their peace production of chemical products to a war output at very short notice. None of these huge installations requires much time for the design and construction of chemical plant for new purposes; all possess a series of standard items of equipment which can be fitted together rapidly to form a piece of plant capable of use for throwing any ordinary laboratory operation into large-scale practice. Stills, condensers, pressure vessels, filter presses, cooling arrangements of coils, and the like, are available in standard sizes and with standard fittings in such a manner that the installation on a works scale of a laboratory operation is deprived of its most formidable difficulties. The question which demands an answer is why, when the German works were in existence and could attain a war production so quickly, were the Allied nations given time gradually to develop their war production of explosives, noxious materials, etc., from nothing? The question is best answered by an example.

In July, 1917, the Germans first used against the Allies a new offensive material, $\beta\beta$-dichloroethyl sulphide, $(CH_2Cl.CH_2)_2S$, and with very great success. This substance, the so-called "mustard gas," has but little odour, and exposure to it causes comparatively few fatalities; inhalation of, or contact with, its vapour gives rise to acute pneumonia when inhaled, to the production of painful sores, and to temporary, or even permanent, blindness. Whilst, as has been stated, the actual mortality is low, and the use of the substance may to this extent be described as humane, the casualties produced are very numerous; slight exposure to a material so toxic and so difficult to detect leads, in general, to six weeks in hospital. The preparation of $\beta\beta$-dichloroethyl sulphide was described by Victor Meyer in 1886, and involved the several operations indicated by the following set of equations:—

(1) $CH_2 : CH_2 + HClO = CH_2Cl.CH_2OH.$
(2) $2CH_2Cl.CH_2.OH + Na_2S = (HO.CH_2\,CH_2)_2S + 2NaCl.$
(3) $(HO.CH_2.CH_2)_2S + 2HCl = (CH_2Cl.CH_2)_2S. + 2H_2O.$

When it is realised that operation No. 1 is difficult, and that the products of reactions (1) and (2) are soluble in water, it will be understood that no small difficulties must present themselves in the manufacture of $\beta\beta$-dichloroethyl sulphide by this process on a large scale. The examination of the German product made it quite clear, however, that the process of manufacture adopted was that indicated by the above set of equations; the over-all yield of product is perhaps 40 to 60 per cent. of the theory. In view of the difficulties of manufacture, it was fairly certain that no chemical installation for its production could be established under the control of the Allies within any reasonable time; the Central nations thus supposed that they held the monopoly of a very powerful instrument of war.

Most British organic chemists were, I think, amazed at the method of production adopted by the German manufacturers; to apply such a technically cumbrous process for the manufacture of so simple a compound seemed quite irrational. By the end of January, 1918, a process for making $\beta\beta$-dichloroethyl sulphide had been worked out in the British laboratories which consisted of the reaction expressed by the following equation:—

$$2CH_2 : CH_2 + S_2Cl_2 = (CH_2Cl.CH_2)_2S + S.$$

The yield obtained in the laboratory was 98 to 99 per cent. of that theoretically possible. The new method was communicated to France and America, and installed by the three great Allies on a large scale; at the conclusion of the armistice the available daily production of mustard gas by the Allies was equal to the monthly production of the Central nations.

The answer to the question just put is now available. The German Chemical Service was inefficient; the scientific chemists under its control were incompetent.

The Allied production of mustard gas had a potentiality of the order of thirty times as great as that of the German; the cost of the German material was of the order of thirty times as great as that of our product. Cost of production under the conditions prevailing for this particular material means, in the end, expenditure in labour; that we were able to produce at something of the order of one-thirtieth of the cost of the German production means that by the allocation of the same quantity of raw materials we could secure thirty times the output. The relative strain on the productive resources of the Allies and the Central nations caused by the demand for a certain quantity of mustard gas is measured, roughly, by the ratio of one to thirty.

Whilst many instances similar to that of mustard gas might be quoted to show that Germany has been badly served by her scientific men during the war, it would be difficult to overrate the effects of the skill and perseverance exhibited by the German chemical manufacturer. The command of great and long-established factories for fine chemical manufacture enabled the German technologist to throw faulty academic projects rapidly into large-scale production. The cost—namely, the strain on national resources—

was enormous, but that an output could have been achieved is a significant tribute to the potentialities represented by the large German fine chemical factories. Both in Britain and in Germany production in chemical manufacture has been multiplied during the war, but necessarily in a different manner. Our large production is almost entirely of war importance, and most of the works installed during the war must now be dismantled as a result of the cessation of hostilities; the German expansions, on the other hand, constitute a permanent addition to the potentialities of peace manufacture of staple marketable products. The war has left Germany with vastly increased resources as a manufacturer of much-needed chemical products.

The view that our country is superior to Germany in the possession of creative scientific power has always been maintained in modern times by students of philosophy and history; the correctness of the view has been amply demonstrated during the last four years. Whilst our nation has overcome its initial handicap by a continuous flow of novel scientific devices of military value, our enemies passed through the war with little more in the shape of novel effects than those laboriously elaborated during the preceding years of peace. The more brilliant position which Germany has so long held in applied science arose from the keen appreciation exhibited by German public and official authorities of the rich economic fruits to be reaped from the systematic exploitation of scientific industry as compared with the neglect of scientific effort shown by corresponding classes in this country. Even yet but small encouragement exists for those who desire to see pure and applied science flourish as it deserves in Great Britain. Although it may be long before the scientific industries of Central Europe regain their former predominance, there seems but little prospect of sufficient official encouragement being given in this country to scientific and industrial initiative to ensure our position in the competition with other nations.

In this connection it is interesting to notice what is happening in the United States. Immediately after her entry into the war America initiated a census of chemists, and in July, 1917, a fully detailed description was available of some 15,000 chemists resident in the States; a research staff consisting of 1200 technical men, with appropriate assistance, was enlisted for the Research Division of the Chemical Warfare Service alone. Since America was only in the war for about eighteen months, this powerful organisation had not time to make its efforts properly felt. Apart from small improvements or changes in detail, practically all the American chemical equipment, for both offence and defence, was manufactured on the detailed plans furnished by Great Britain or France; the available time was too short to allow full play to American genius for novelty and for magnitude of production. The necessity for co-operation brought large numbers of young and active American chemical officers to Europe; it gave those officers for eighteen months the entry to practically every chemical works of importance in England and France, and unrivalled opportunities for accurately judging European chemical methods and markets. Those men have now returned to their ordinary scientific and technical pursuits in the States, and it cannot be expected that they have left behind them the unique experience which they have gained of European conditions.

We may anticipate that competition in pure and applied chemistry between Europe and America will become increasingly keener during the years to come. The competition is already intense, and gives little promise as yet of turning in our favour; it is, in fact, difficult to see how many of the staple products of fine chemical manufacture can hold their own in Great Britain against American competition under the conditions which arose during the first three years of the war. During these years peace production flourished in the States free from Government control, whilst in this country the establishment of a fine chemical industry in war-time was naturally rendered far more difficult by State control of works, materials, and labour.

The bearing of this may be made clearer by an instance. The manufacture of saccharin was installed in England after the outbreak of war, but the production was controlled in that the manufacturers were only permitted to sell at a profit of 10 per cent. on the cost, this profit being, in turn, subject to the excess profits tax; further, to prevent the economic difficulties which were foreseen if saccharin competed with sugar, the price of English-made saccharin was fixed at a figure which involved the very large addition of 30*s*. per lb. to the price, this addition being appropriated by the Government. Simultaneously, saccharin was manufactured free of all control in the States; it came into this country unrestricted and on such terms that the American producer took the 30*s*. per lb. just mentioned in addition to the considerable profit previously made by reason of lower cost of manufacture. America, having thus been assisted by our Government to build up a large reserve of profits, is now actually selling saccharin in England at 11*s*. per lb.—a price at which it cannot be produced here—apparently with the legitimate trade purpose of destroying the English manufacture and afterwards running up the price.

Many cases may be quoted as closely analogous to that of saccharin, notably in connection with acetic acid, glycerol, acetone, and methyl alcohol and their products, in which British procedure has facilitated profiteering in foreign countries during the war. The excess profits tax operated insidiously in tempting British manufacturers to keep prices high so as to retain a margin with which to write off capital expenditure in spite of the tax; the foreign competitor, free from Government control of raw materials and exempt from the excess profits tax, was able to take full advantage of the ruling high rates. It will be of interest to see how the problems introduced by these actual occurrences are to be solved advantageously for Great Britain in the great reconstruction upon which our administrators are now engaged.

Sufficient has probably now been said in justification of the rapid appreciation of science, and especially of that branch of science with which we are particularly concerned, in the public and administrative eye. The sudden incidence of new scientific modes of military and naval attack, and the quick improvisation and development of equally scientific means of reply, both of which have been so frequently exhibited during the past five years, must have seemed uncanny to the lay observer, who only realised the effects, but did not understand the causes.

At the present time, however, most fellows of this society have little leisure to reflect upon the ghastly tragedy in which it has been our privilege to assist; the curtain has fallen upon this, but is rising again upon the greatest epoch in the history of the world. The coming struggle for scientific and industrial position, upon the results of which must rest the whole intellectual, artistic, and material future of our race, will call for longer, greater, more persistent, and more intelligent effort than any which we have hitherto exerted. We are forced to consider whether we have reason to hope that the recent lessons have been well brought home, and whether the free play given to scientific creation and production during the last five years is to persist unhampered in the future. For purposes of war our administrators gave every incentive to scientific investigation; money, men, and material were provided for the asking, free from Treasury control—free, in fact, from all control other than that of the scientific worker able and willing to organise and execute a necessary piece of work.

I see no reason to think that the lesson has been properly learnt, and every reason to anticipate a re-establishment of that parsimonious treatment of scientific effort which seems now to belong to a past age, but with which we were all well acquainted five years ago. The control of scientific research is again leaving the hands of the scientific man and being resumed by the lay administrator. The old remark has been resuscitated quite recently that "it is a commonplace among administrators to fear the expert." The non-technical administrator has no means of distinguishing the expert from the charlatan; he has, perforce, to regard the scientific expert as the lineal descendant of the "adept" of alchemical times, whose main claim to recollection is based upon the adroitness with which he was able to divert public funds to his own base purposes.

It is quite clear that if scientific research is to be assisted by the State—and unless so aided it will languish, and carry with it into decadence every activity of the Empire—it must be administered by men of scientific training and eminence; any other mode of procedure will necessarily lead to the strangulation of scientific effort by departmental red tape. In this connection it is again instructive to refer to American practice. Our blood-relatives across the Atlantic had three years in which to study in peace the efforts which we were making in war, and it cannot but be useful to observe the manner in which they propose to profit by our experience.

In 1916 President Wilson, a university professor and an expert, now one of the most imposing figures in terrestrial affairs, called upon the National Academy of Sciences at Washington to nominate the members of a "National Research Council"; the object of this new organisation was stated to be that of co-ordinating the scientific work of the country in order that the scientific problems both of war and of peace might be more efficiently solved. The National Research Council is under the presidency of one of the most eminent among the active American men of science, Prof. George E. Hale, of the Mount Wilson Observatory, and has large funds at its command for research purposes. Two points are conspicuous in connection with the American programme—first, the substitution of the professional lay administrator by the ordinary office staff; secondly, the recognition of the close interdependence of pure and applied science. The contention which has long been advanced in this country, that an adequate output of purely academic chemical research work and the existence of a flourishing fine chemical industry are mutually essential, is here tacitly accepted; the former seeks in the industries remunerative positions for the products of its training, and the fine chemical industry looks to the scientific investigator for inspiration and new directions for enterprise. The nation which possesses an extensive organic chemical industry controls chemical warfare, the production of pharmaceutical and photographic products, the textile industry, and many other great departments of human activity.

The operations of the great American organisation for the stimulation of scientific research work are already making themselves felt. They have produced just recently an entirely novel method for oxidising naphthalene to phthalic acid, presumably by the use of atmospheric oxygen and a catalyst, which gives a 95 per cent. yield, and are responsible for the huge nitrogen fixation scheme now under installation in the States. These two illustrations alone, the one small and the other large, leave us in no doubt as to the influence which the National Research Council is destined to exert on scientific and technical progress throughout the world.

If British science is to make itself adequately felt in the great intellectual and material advances of the near future, British men of science must be entrusted with the initiative power and the command of money which they have enjoyed during the past few years; unless this is done our Empire will, as before, continue to fall behind other great nations as a contributor to the increasing mass of pure and applied scientific knowledge.

In an address which I had the honour of delivering in this room a year ago attention was directed to the necessity for closer co-operation between the large societies representing the various chemical interests in Great Britain. During the past year action has been taken in this matter, and some fifteen of the societies have now collaborated in the establishment of a Federal Council for Pure and Applied Chemistry, the function of which is to advance, safeguard, and voice the interests of chemical science. The Federal Council consists of representatives nominated by the component bodies, and is already occupying itself actively with the questions within its purview; it has moved with some success in connection with the claims of experimental science to recognition in the recently established scheme for education within the Army, with the provision of fine chemicals for research purposes, with the remuneration of scientific posts, and with other matters. The Federal Council will continue to apply itself to those questions which are of importance to chemists as a class, leaving more specific chemical interests to be dealt with by the appropriate constituent societies. A very similar project for the consolidation of the larger chemical interests is in course of execution by our French colleagues.

It is beyond question that a central house for accommodating the chemical societies in a manner more proportionate to their importance than is at present possible should be provided; that a common chemical library far more complete than any now available in this country should be at our service; and that some comprehensive scheme for the publication of compendia of chemical knowledge should be put into operation. A very imposing and costly programme confronts the recent amalgamation of chemical interests, but the universal approval which greeted the proposition for creating a Federal Council for Pure and Applied Chemistry is a happy augury for the future usefulness of the new organisation.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

BIRMINGHAM.—At a meeting in Birmingham on May 8 of representatives of the engineering profession and others, the Lord Mayor presiding, a provisional scheme for celebrating the centenary of the death of James Watt was agreed upon. We are glad to note that the scheme includes the endowment of a chair of engineering at the University. A point which is sometimes overlooked in such matters was made by Sir Oliver Lodge, who reminded the meeting that endowments of this kind, though most desirable, should not be regarded as gifts conferring benefit only on the University. The University acted as a trustee, and every new chair endowed involved expense. Apparently no definite opinion was expressed as to the salary which should be attached to the chair; this would no doubt depend upon the sum collected for the memorial.

Taking into consideration, however, the vast benefits accruing to the world from the genius of James Watt, we may hope that the endowment will be a liberal one, so that the full services of the best possible men may be secured. If a considerable sum could also be allotted as an endowment for the department over which the professor would preside, and a further amount to provide valuable research scholarships for promising students from any part of the Empire, a memorial worthy of the subject might be established. For example, the appointment of a professor, for ten years at a time, with a salary of 500*l.* per annum, with a like sum towards the upkeep of the department, and, in addition, the provision of ten scholarships each of 50*l.* per annum tenable for two years, might cost 300,000*l.*, but the money would be profitably invested.

The evacuation of the University buildings by the military hospital authorities is proceeding rapidly, and it is hoped that the departments of physics and chemistry at least may be reinstated in their proper quarters by October next. The appointments of the new professors of physics and chemistry (Prof. S. W. J. Smith and Prof. G. T. Morgan) have accordingly been made as from July 1 in order that they may supervise the restoration of their respective departments.

CAMBRIDGE.—A gift of 210,000*l.* to the University for a chemical school was announced by the Vice-Chancellor, Dr. A. E. Shipley, at the meeting of the Senate on May 13. Particulars were given in the following extracts from a letter from Mr. R. Waley Cohen:—"It has been an immense pleasure to me to be able to write to Sir William Pope and tell him that the British oil companies have agreed to join together in a scheme for endowing a chemical school at Cambridge. The Burma Oil Co. have agreed to contribute 50,000*l.*; the Anglo-Persian Oil Co., 50,000*l.*; the Anglo-Saxon Petroleum Co., 50,000*l.*; and Lord Cowdray and the Hon. Clive Pearson between them 50,000*l.*, making the total of 200,000*l.* which is required. Mr. Deterding, who has taken very great interest in the scheme from the beginning, has offered to make the 200,000*l.* into guineas by adding a personal contribution of his own of 10,000*l.*"

LONDON.—The annual report of the Vice-Chancellor of the University (Sir Cooper Perry), which was read at the presentation day ceremony in the Albert Hall on May 9, was naturally written in a more cheerful strain than previous reports during the war. *Cedant arma togae*—at last the University is able to turn from the works of war, to which the Vice-Chancellor was able to refer with just pride, both in the fields of battle and of science applied to warfare, to a conflict in which "the weapons are no longer 'reeking tube and iron shard,' but the highest qualities of insight and spiritual temper." The list of gifts and benefactions during the past year indicates the wide appeal of the University, including generous provision for the teaching of aviation, modern Greek, Portuguese (in all of which new chairs have been established), and a German field-gun given by the War Office in recognition of the work of the Officers Training Corps during the war. Progress has been made with the scheme for degrees in commerce, and an institute of phonetics is to be established at University College.

OXFORD.—At a prolonged sitting of Congregation, held on May 6, various amendments to the statute which aims, amongst other objects, at making Greek optional instead of compulsory in Responsions were taken into consideration. Most of the amendments would have had the effect of limiting somewhat the choice of subjects, but all were rejected except one, which makes it possible to omit all the subjects of "Group II." (English, French, and German), and another concerning the fee for entrance to the examination. The statute as amended will have to come before a further meeting of Congregation, and if passed by that body, to be submitted to Convocation, where the final decision will be taken.

MR. G. R. BENNETT has been appointed principal of the Technical Institute, Newport, Mon.

MR. ANDREW W. YOUNG has been appointed to the post of lecturer on pure and applied mathematics at the Sir John Cass Technical Institute, Jewry Street, Aldgate, E.C.3.

PROF. C. R. MARSHALL, professor of materia medica and therapeutics, University of St. Andrews, has been appointed to the Regius chair of materia medica in the University of Aberdeen, vacant by the resignation of Prof. Theodore Cash.

APPLICATIONS are invited for the following awards in connection with the Armstrong College, Newcastle-upon-Tyne:—The Earl Grey memorial fellowship, value 300*l.*; the Royal (1851) Exhibition scholarship, value 200*l.*; and industrial bursaries, each of the value of 150*l.* The names of candidates must reach the secretary of the college by, at latest, May 31.

THE Higher Education Sub-Committee of the London County Council has had under consideration the report of the Government Committee appointed to inquire into the position of natural science in the educational system of Great Britain. In view of the importance of the subject, and of the value of the report, it is desirable that the conclusions and recommendations should receive the fullest consideration and discussion among those concerned in the teaching of natural science. The sub-committee has therefore arranged a meeting at County Hall, Spring Gardens, at four o'clock on Friday afternoon, May 30, to which the principals of the schools of the University, headmasters and headmistresses of secondary and central schools, principals of polytechnics and technical institutes, and science teachers of these colleges and schools have been invited. Sir J. J. Thomson, chairman of the Government Committee, has consented to address the meeting, and Sir Cyril Cobb, chairman of the Education Committee of the London County Council, will take the chair.

ANNOUNCEMENT is made in the *Times* that the Government proposes (if Parliament agrees) to expend during the next five years about 2,000,000*l.* on agricultural research and agricultural education. Substantial scholarships will be offered to men who have distinguished themselves in the natural sciences at the universities, and a certain number will be selected for employment in universities and other institutions. Research is already carried on at Cambridge, Rothamsted, Bristol, and Reading; but whereas at present there are probably not more than forty men in England and Wales engaged on pure research in agricultural science, it is hoped that during the next decade or so the number may be raised to about 150. Another feature will be the encouragement of higher agricultural education in colleges by means of grants and in other ways. There are about a dozen agricultural colleges in England and Wales, and it is hoped to bring the farmer into more sympathetic touch with them by the creation of more demonstration farms and of a keener sense of the general value of science in agriculture.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Microscopical Society, April 16.—Mr. J. E. Barnard, president, in the chair.—J. **Strachan**: The chemistry of dendritic growths in paper. The formation of these interesting and curious growths was formerly attributed to the oxidation of a particle of bronze or brass included in the sheet of paper during manufacture. Later investigations have proved, however, that the chemical reactions producing these growths are more complex. The particle of bronze is attacked by chemical residues in the paper, chief among which is sulphate of aluminium, with the formation of soluble sulphate of copper. The latter creeps along the fibres in solution. The sulphate of copper is then reduced to insoluble black sulphide of copper, which constitutes the majority of recent dendrites in paper. This sulphide is further oxidised again to sulphate, and so by alternate oxidation and reduction insoluble copper compounds may be deposited along the fibres. The final action in old dendrites is oxidation, resulting in the formation of basic copper sulphate. The chemistry of these growths is important in that they indicate, by secondary reactions, the nature of chemical actions taking place in the deterioration of paper during ageing, in which the cellulose is attacked by chemical residues from various sources. A new micro-chemical test for the detection of copper sulphide consists in the application to the dendrite of a solution containing the double cyanide of potassium and cadmium. The black copper sulphide dissolves, but is exactly replaced by a brilliant yellow pseudomorph of cadmium sulphide, forming a yellow dendrite. The principle of this mode of testing by replacement appears to be capable of further applications in micro-chemical manipulation.—Dr. E. **Penard**: *Folliculina boltoni*, S. Kent. In spite of recent statements to the contrary, the genus Folliculina is undoubtedly represented in fresh-water, and the vermiform bodies (described as *Lagynus ocellatus* by Daday) represent, as already suspected by several authors, though contradicted by others, a free-swimming form produced by a metamorphosis of the whole individual.

Zoological Society, April 29.—Prof. E. W. MacBride, vice-president, in the chair.—Dr. W. T. **Calman**: Marine boring animals. Attention was directed to the economic importance of the scientific investigation of these forms of marine animals in relation to the serious damage caused by them to the timbers of wooden ships and to piers, and to the masonry of breakwaters and similar constructions.—G. **Jennison**: A chimpanzee in the open air in England. Attention was directed to the fact that the animal had lived in a healthy and vigorous condition for a period of some eight years in the private grounds of its owner, Dr. John K. Butter, of Cannock, Staffordshire.

Linnean Society, May 1.—Sir David Prain, president, in the chair.—J. **Smith**: Forms assumed by the pappus in Compositæ. As all the facts adduced in support of the phyllome theory can be explained by assuming that the pappus in certain cases is partly a development of the hairs which were inserted on the now aborted but once free calyx-segments, the evidence in favour of the trichome or emergence nature of the organ admits of no other conclusion than that which takes the pappus to be hairs, free or fixed, derived in their evolution from the hairs of the achene, or sometimes also from the hairs of the now aborted calyx-limb.—J. M. F. **Drummond**: The flora of a small area in Palestine. The author gave the route covered by the 52nd Division (of which he was a member) between El Arish and the neighbourhood of Jaffa. Collections were made at various points along this route, and the area of Arsuf, fifteen miles north of Jaffa, was specially described, with the topography and climate. The edaphic plant-formations were dealt with, especially two—the "Calcareous Knoll" flora and the "Cistus Moor"; the former is of the nature of garigue, and contains many geophytes and annuals, with many minor xerophilous characters, but few extreme types, with only one switch-plant and no succulents. Cistus Moor has a closed carpet of vegetation, few geophytes or annuals. Cistineæ and a tussock-grass predominate; possibly akin to the Cistus-maqui of Spain. Garigue and Steppe prevail in western Palestine; Maqui was not seen at all by the author. Possibly this state of affairs is partly due to man's interference.

DUBLIN.

Royal Irish Academy, April 28.—Dr. R. F. Scharff, vice-president, in the chair.—N. **Colgan**: The occurrence of tropical drift seeds on the Irish Atlantic coasts. Seeds or fruits of no fewer than eight tropical species have been found, cast up from time to time, on the Irish coasts. All the species are native or naturalised in the West Indies, and all have highly buoyant seeds, capable, as Dr. Guppy has shown, of floating for twelve months and upwards. The Irish stations for these drift seeds range from Donegal to Kerry, and the records of their occurrence are spread over a couple of centuries. It has been suggested that the passage of these ocean waifs is effected by human agency. The author decides in favour of the idea that the tropical drift seeds cast up on the Irish Atlantic beaches are wafted thither from their West Indian home by natural agencies. An account of the seeds and of the plants which produce them is given.—D. P. **Montagu**: A study in regeneration in wheat (*Triticum vulgare*). A number of simultaneous sowings of wheat were made, and shoots were amputated at various stages in their development. The various theories of regeneration were reviewed in the light of the facts disclosed in Triticum, and two hypotheses were put forward, viz. (1) the regeneration observed may be traced to the disturbance in the normal absorption-transpiration-equilibrium, following the removal of the shoots by amputation, and (2) the regeneration observed may be regarded as due to the disturbance, consequent on the injury involved in the amputation, of the normal enzyme-balance. Such a disturbance leads to hydrolysis of glucoside within the plant, the cyclic element functioning as the direct causal activator of the regenerating growths, while the carbohydrate split-product is utilised to build up the regenerating tissue.

BOOKS RECEIVED.

Outlines of Theoretical Chemistry. By Dr. F. H. Getman. Second edition. Pp. xiii+539. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 16*s*. 6*d*. net.

Applied Optics. The Computation of Optical Systems, being the "Handbuch der Angewandten Optik" of Dr. A. Steinheil and Dr. E. Voit, translated and edited by J. W. French. Vol. ii. Pp. vi+207+plates v. (London: Blackie and Son, Ltd.) 12*s*. 6*d*. net

Reports of the Progress of Applied Chemistry. Issued by the Society of Chemical Industry. Vol. iii. Pp. 495. (London: Society of Chemical Industry.) 10*s*. 6*d*.

How and What to Read. Suggestions towards a Home Library. By R. B. Buckley. Pp. 176. (London: Williams and Norgate.) 2*s*. 6*d*. net.

Meteorologia Aeronautica. By Prof. G. Crestani. Pp. xv+315. (Milano: U. Hoepli.) 8.50 lire.

Dizionario Internazionale di Aeronavigazione e Costruzioni Aeronautiche. Italiano, Francese, Inglese, Tedesco. By M. Dander. Pp. vii+227. (Milano: U. Hoepli.) 6.50 lire.

A Practical Handbook of British Birds. Edited by H. F. Witherby. Part ii. Pp. 65-128+3 plates. (London: Witherby and Co.) 4*s.* net.

The Theory of Heat. By Prof. T. Preston. Third edition. Edited by Prof. J. R. Cotter. Pp. xix+840. (London: Macmillan and Co., Ltd.) 25*s.* net.

Text-book of Embryology. Vol. ii., Vertebrata with the exception of Mammalia. By Prof. J. Graham Kerr. Pp. xii+591. (London: Macmillan and Co., Ltd.) 31*s.* 6*d.* net.

Manual of Tree Diseases. By Dr. W. H. Rankin. Pp. xx+398. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) 12*s.* 6*d.* net.

Our National Forests. A Short Popular Account of the Work of the U.S. Forest Service on the National Forests. By Dr. R. H. D. Boerker. Pp. lxix+238. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) 12*s.* 6*d.* net.

The Mycetozoa: A Short History of their Study in Britain. By G. Lister. Pp. 54. (Essex Field Club Special Memoirs, vol. vi.) (Stratford: Essex Field Club; London: Simpkin, Marshall, and Co., Ltd.) 3*s.* net.

Boiler Chemistry and Feed-water Supplies. By J. H. Paul. Pp. ix+242. (London: Longmans and Co.) 14*s.* net.

Text-book of Physical Chemistry. By Prof. A. T. Lincoln. Pp. viii+547. (London: G. G. Harrap and Co., Ltd.) 12*s.* 6*d.* net.

A Text-book of Physiology. By Drs. M. Flack and L. Hill. Pp. viii+800. (London: E. Arnold.) 25*s.* net.

Les Applications de la Physique Pendant la Guerre. By H. Vigneron. Pp. viii+322. (Paris: Masson et Cie.) 7 francs net.

Cotton Spinning. By W. Scott Taggart. Vol. i., Including all Processes up to the End of Carding. Sixth edition. Pp. liii+322. (London: Macmillan and Co., Ltd.) 7*s.* 6*d.* net.

The Newer Knowledge of Nutrition: The Use of Food for the Preservation of Vitality and Health. By E. V. McCollum. Pp. ix+199. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) 6*s.* 6*d.* net.

DIARY OF SOCIETIES.

THURSDAY, MAY 15.

ROYAL INSTITUTION, at 3.—Prof. F. Keeble: Intensive Cultivation.

ROYAL SOCIETY, at 4.—Election of Fellows.—At 4.30.—Prof. W. H. Young: (1) The Area of Surfaces; (2) Change of the Independent Variables in a Multiple Integral.—Prof. W. A. Bone and R. J. Sarjant: Researches on the Chemistry of Coal. I. The Action of Pyridine upon the Coal Substance.—Prof. E. F. Burton: A New Method of Weighing Colloidal Particles.—W. E. Curtis: The Value of the Rydberg Constant for Spectral Series.

ROYAL SOCIETY OF ARTS, at 4.30.—Prof. H. E. Armstrong: Soil Deficiencies in India, with Special Reference to Indigo.

MATHEMATICAL SOCIETY, at 5.—G. N. Watson: Zeros of Lommel's Polynomials.—W. H. Young: The Triangulation Method of Defining the Area of a Surface.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—E. A. Laidlaw and W. H. Grinsted: The Telephone Service of Large Cities, with Special Reference to London.

CHEMICAL SOCIETY, at 8.—B. Blount and J. H. Sequeira: "Blue John" and other Forms of Fluorides.—G. M. Bennett: The Nitration of Diphenylethylenediamine.—D. L. Hammick: The Destruction of Picric Acid in Nitrating Acid.—J. C. Irvine and J. S. Dick: The Constitution of Maltose. A New Example of Degradation in the Sugar Group.—R. J. Manning and M. Nierenstein: The Tannin of the Canadian Hemlock (*Tsuga Canadensis*, Carr).

FRIDAY, MAY 16.

ROYAL INSTITUTION, at 5.30.—Dr. S. F. Harmer: Sub-Antarctic Whales and Whaling.

MONDAY, MAY 19.

ROYAL GEOGRAPHICAL SOCIETY, at 5.—Capt. W. B. R. King: The Uses of Geology in War.

INSTITUTE OF METALS, at 8.—Ninth Annual May Lecture—Prof. F. Soddy: Radio-activity.

TUESDAY, MAY 20.

ROYAL INSTITUTION, at 3.—Prof. A. Keith: British Ethnology—The People of Ireland.

BRITISH ASSOCIATION GEOPHYSICAL DISCUSSIONS (Royal Astronomical Society, Burlington House), at 5.—Col. H. G. Lyons will open a discussion on The Functions of a Geodetic Institute. Followed by Sir J. Larmor, Sir C. F. Close, Mr. A. R. Hinks, and others.

INSTITUTION OF PETROLEUM TECHNOLOGISTS, at 5.30.—Dr. F. Mollwo Perkin and T. C. Palmer: The Chemist and Engineer in Relation to the Petroleum Industry.

WEDNESDAY, MAY 21.

ROYAL SOCIETY OF ARTS, at 4.30.—Sir Francis T. Piggott: The Principles o Japanese Design.

ROYAL METEOROLOGICAL SOCIETY, at 5.—Capt. C. J. P. Cave and J. S. Dines: Further Measurements on the Rate of Ascent of Pilot Balloons.—J. E. Clark and H. B. Adames: Report on the Phenological Observations for 1918.

GEOLOGICAL SOCIETY, at 5.30.

THURSDAY, MAY 22.

ROYAL INSTITUTION, at 3.—Prof. F. Keeble: Intensive Cultivation.

ROYAL SOCIETY, at 4.30.—*Probable Papers:* Prof. W. J. Sollas: The Structure of Lysorophus as Exposed by Serial Sections.—O. Rosenhein: A Preliminary Study of the Energy Expenditure and Food Requirements of Women Workers.—M. Greenwood, C. Hodson, and A. E. Tebb: Report on the Metabolism of Female Munition Workers.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—Dr. S. Chapman: Electrical Phenomena occurring in High Atmospheric Levels.

SATURDAY, MAY 24.

LINNEAN SOCIETY, at 3.—Anniversary Meeting.

CONTENTS. PAGE

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

Advertisements and business letters to be addressed to the Publishers.

Editorial Communications to the Editor.

Telegraphic Address: PHUSIS, LONDON.
Telephone Number: GERRARD 8830.