THURSDAY, JUNE 6, 1918.

SYMMETRY IN NATURE.

Lectures on the Principle of Symmetry and its Applications in All Natural Sciences. By Prof. F. M. Jaeger. Pp. xii+333. (Amsterdam: "Elsevier" Publishing Co., 1917.)

THIS is a book of unusual character, written by a Dutchman, Dr. F. M. Jaeger, professor of inorganic and physical chemistry at the University of Groningen, Holland, who is personally known to many English and American men of science from his visits to this country and the United States, and who is not only a chemist, but also, what is infinitely rarer, an accomplished crystallographer. Although published in Amsterdam, it is written in the English language, and dedicated to an Englishman, the president of the Chemical Society, Prof. W. J. Pope.

These alone are reasons why a welcome should be given to the book; but its own merits are also adequate to deserve it. The author is well known for his researches on enantiomorphism and optical activity, for his crystallographic investigation of the hexagonal ethyl sulphates of the rare earths and other substances, and most recently for a series of beautiful photographs of Laue X-radiograms taken with the crystals of a considerable number of important substances. Prof. Jaeger is obviously a great admirer of the work of Prof. Pope, for which the latter received the Longstaff medal of the Chemical Society, on the relation between the crystal form of optically active substances and their chemical nature, on the true character of a racemic substance as a molecular compound of the two optically active antipodes, and of a pseudo-racemic substance as an intimate, exceedingly fine, alternating repetition of the two varieties, and his work generally in confirming Pasteur's law.

The most important section of the book, its latter half, is devoted to an excellent summary of these investigations and those of other workers in this domain, together with their relation to the theories of van't Hoff and Le Bel concerning the asymmetric carbon atom, and to the further work of Pope and Kipping on the asymmetric atoms of nitrogen, sulphur, selenium, tin, silicon, and phosphorus. Practically everything that is surely grounded in chemical crystallography is clustered around the two subjects of enantiomorphism and isomorphism, and it is the former only that is dealt with in this book, the latter being scarcely touched, which is somewhat of a disappointment.

In yet another aspect, however, the book is remarkable. It deals with the principle of symmetry, applied so generally as to include the animal and vegetable kingdoms as well as crystals. One of the happiest features is the excellent photographic figures of highly symmetrical living objects, such as radiolaria, *Circoporus octahedrus, Circorhegma dodecahedra, Circogonia icosahedra,* pollen seeds, fruits, and especially flowers. Indeed, the amount of ground covered is well-nigh bewildering. The first four chapters deal with the nature, æsthetic value, and laws of symmetry; with the deduction of symmetry character as a mathematical problem; with mirror-image repetition by reflection and inversion; with the derivation of the possible types of symmetry by the method of groups of movements; and with the applications to the morphology of crystals, plants, and animals.

Chap. vi. is omnivorous, for it deals with the systems of crystal symmetry, the derivation of the 230 types of homogeneous crystal structures and of the thirty-two classes into which they fall, including the fourteen Bravais space-lattices, the sixty-five regular point-systems of Sohncke, and the methods of Schönflies, Federov, and Barlow for deriving the rest of the 230 types by use of mirror-image repetition; with the space-lattice in relation to Hauy's law; with the Barlow-Pope valency volume theory; with the diffraction and reflection of X-rays by the planes of atoms in crystals, and the X-ray analytical methods of Laue and Bragg; with the existence or otherwise of chemical molecules in crystals; with Werner's co-ordination theory; and in conclusion with phyllotaxis, the symmetrically spiral arrangement of the leaves of plants. It is, however, in the latter part of the book, and especially in the two chapters on Pasteur's law, that the author is at his best. He concludes with some valuable suggestions for further research, especially as regards the premier problem of bio-chemistry, the asymmetric synthesis of organic molecules.

It is interesting that Prof. Jaeger does not commit himself to a definite opinion concerning the Barlow-Pope valency volume theory, although he points out that the X-ray work has not afforded any support to the theory, and he clearly perceives the futility of tampering with axial ratios. As regards the persistence of the molecule in the crystal, one is glad to see that the author agrees that geometricians have gone too far in deleting the molecule as an entity in the solid crystal, for he rightly points out that although the crystal structure is essentially one of atoms, still the molecule remains in position, and unless its entity be admitted, all kinds of difficulty arise as to valency, interatomic forces, enantiomorphism of the chemical molecule, effect of solution, and so forth, all of which are insoluble on the purely atomic assumption.

As above mentioned, isomorphism is not dealt with, doubtless because the symmetry remains the same in all isomorphous substances. Consequently the law of progression with atomic number, of the crystal angles, elements, and physical constants, in such series as the rhombic sulphates and selenates of the alkalis and the monoclinic double sulphates and selenates containing $6H_2O$, now so thoroughly established and so perfectly explained by Moseley's law connecting the atomic number with the complexity of the atom, is not referred to. Yet in the

writer's opinion it forms a very beautiful addendum to Prof. Jaeger's principle, especially as these regular differences become smaller as the symmetry becomes higher, until in such series of relatively high symmetry as the hexagonal ethyl sulphates of the rare earths investigated by Prof. Jaeger they are reduced almost to the limits of experimental error, while in the cubic system they disappear altogether. One statement made by the author can scarcely be accepted, that isomorphism is only a special case of morphotropy. For in an isomorphous series the space-lattices, and therefore the volumes and edge-dimensions of their cells relatively expressed by the molecular volumes and topic axes and confirmed by absolute measurement by X-rays, are strictly comparable, whereas the cells of morphotropic substances are not at all necessarily comparable, and, in general, are probably not so.

Some of the drawings could well be improved, but the photographic figures of biological objects and X-radiograms are excellent. Before another edition is printed numerous slight errors in English and spelling should be eliminated with the aid of some English friend. The author's power of expressing himself in our language is, however, surprising, and often truly excellent.

The book is an inspiring one, and well worthy of the attention of both chemists and biologists. If stereochemists had all been forced to take an elementary course of crystallography they would have avoided much of the acrimony of the long-drawn-out discussion over asymmetric atoms, the exact conditions being plain; and they would have recognised right away that the presence or absence of a plane of symmetry is not the test for optically active enantiomorphism. The reason why Prof. Pope's work in this domain is so well grounded, and why we listen also to Prof. Jaeger with such confidence, is that both are not only stereochemists, but also practical crystallographers. The moral is clear.

A. E. H. TUTTON.

ELECTRICITY METERS.

Electricity Meters: their Construction and Management. A Practical Manual for Central Station Engineers, Distribution Engineers, and Students. By C. H. W. Gerhardi. Second edition, revised and enlarged. Pp. xx+504. (London: Benn Bros., Ltd., 1917.) Price 15*s.* net.

THE function of an electricity meter is to make an accurate record of the energy expended in a consumer's appliances. The principles on which it works are well known, but without having recourse to the integral calculus it is difficult to explain how it fulfils its functions. On p. 3 of this book, for instance, the author has to explain that what it measures is the integral of the product of two functions of the time, namely, the pressure and the current. In fact, an electricity meter is a most wonderful calculating machine, which has been gradually evolved by the joint labours of mechanical inventors, electricians, and mathematicians. Although it is generally placed in some out-of-the-way position, where it is looked on with disfavour by the domestics, yet it performs its wonderful operations with the highest accuracy from year to year. Manufacturers also turn out many thousands of "tariff" meters—that is, meters which will let you have a cheaper supply at one period of the day when the demand is small, and a dearer supply at the times of the "peak" load. In addition, many thousands of penny, sixpenny, and shilling "in the slot" meters are in daily operation. In nearly all cases when the electricity paid for is exhausted, the lights go out, but in some cases an intolerable blinking of the lights occur. As more than one coin can usually be inserted in a meter, there is a dial showing the number of "unconsumed coins" remaining in it.

One good effect of the lighting restrictions will be that it will make many householders read their meters once a week. When they have mastered this accomplishment it will begin to dawn on them what an admirable servant an electricity meter is. If they are skilled observers they may be able to detect slight differences in its rate, but unless they are very skilled, or the meter does something outrageous, it will not be safe to dispute the reading with the supply company. From a long experience of "disputed" meters the writer finds, from his official tests, that only about 10 per cent. of them are outside the limits of permissible error. He has known, however, a meter where the thousand dial of the cyclometer counting train made a jump of 2000 units instead of 1000, and yet on inspection of the train and on an official test over the disputed part of the dial it behaved normally. The consumer, however, being a careful man, entered the weekly readings in a book, and thus proved conclusively its nefarious deed. A flaw in the mechanism, discovered later, proved how it happened.

The most difficult errors to detect in meters are in connection with the wheel train. Sometimes it requires more power to turn it in certain positions of the dials than in others, and tests to detect this fault are difficult to devise. In the study of friction losses great progress has been made. These losses are due to the commutator brushes (which are sometimes made of gold), the bearing, the gearing, and air friction. The friction of the bearing and gearing is practically constant at all loads. The brush and air friction increase with the load, and, therefore, with the speed of the spindle, but the latter does not obey the parabolic law. In some cases the total friction torque appears to attain a minimum value at low speeds. When the spindles are supported by cupped diamond bearings the bearing friction is very small. Sometimes it is eliminated altogether by keeping magnetically the rotating part floating in the air.

This book should prove most useful for those for whom it is written. The practical hints given in the chapters on "Choice of a Type of Meter" and on "Meter Testing" are good. The diagrams in the latter chapter are worthy of commendation. Several of the meter illustrations, however, are very poor, and could have been omitted with ad-

vantage. The author refers throughout to the kilowatt-hour as the B.T.U., which is a contraction for the Board of Trade (electrical) unit. It is therefore liable to be confused with the British thermal unit (B.Th.U.). In this edition a new chapter on polyphase meters and the measurement of polyphase power has been added, all the well-known mathematical theorems being clearly given. We sometimes wonder whether these theorems will be included in the school studies of the coming generation. A. RUSSELL.

NATURAL HISTORY OBSERVATIONS.

The Young Observer's Handbook. By W. P. Westell. Pp. 317. (London: McBride, Nast, and Co., Ltd., 1918.) Price 7*s.* 6*d.* net.

THIS book will be useful in giving practical hints to young observers who have the root of the matter in them. It gives hints about collecting, preserving, and mounting; about microscopic work and photography; about keeping pets and making little museums; about aquaria and vivaria. It also suggests how the young naturalist may set about exploring shore-pools, ponds, and other haunts of life; or how he may make much of the wild life of a garden. On the last topic we have the best part of the book. The idea of providing an all-round introduction to practical Nature-study is good; the mood of the book is wholesome; and the text has been kept simple. We are sorry to have to say that the style is easy-going and inelegant. But there is in Mr. Westell's work an enthusiasm for Nature-study that inclines one to forgive a good deal. Young observers will find in the book many suggestions which will make them more efficient, but we think and hope that they will, even when grateful, resent the author's tendency to "talk down" and his not infrequent wordiness.

The book is liberally illustrated with one hundred and fifty photographs, diagrams, and sketches, many of which are of much interest. We wish Mr. Westell's standard of precision and accuracy had been higher, for it is by example as much as by precept that young observers learn that they can never go far unless they are doggedly precise and accurate. Besides a frequent vagueness in the book, there is a lack of carefulness, which is regrettable. Thus the figure of a so-called Nautilus is quite wrong. It is a fictitious Nautilus, which should not have been allowed to figure in a scientific book. It is, we think, a pity to tell boys and girls that "newts pass through a similar metamorphosis to their relatives, the frogs and toads. They also have, like them, a supplemental breathing apparatus when grown up, consisting of pores in the skin." Many other examples might be given. Changing the subject a little, we do not think that it profits much to write: "I do not know that it matters whether the young naturalist should be aware of the fact that some fishes have teeth, whereas others are toothless. We do not judge a man or woman, a boy or girl, by being toothless. We judge him or her by the life that is led, and as such we may also judge fishes." But this Daniel come to judgment has not judged rightly in including in his handbook for young observers, with a delightful "foreword" from Marcus Aurelius (to which name the author characteristically adds "Antonius"), three lists of the old horrors of connate leaves, ochreate stipules, runciform shapes, æterio of follicles, and the regma.

OUR BOOKSHELF.

A Flora of Epsom and its Neighbourhood. By the Rev. T. N. Hart Smith-Pearse. Pp. ix+107. (Epsom: L. W. Andrews and Son, 1917.) Price 3*s.* 6*d.* net.

THE late Headmaster of Epsom has worthily carried on the traditions which he established at Marlborough, and in his flora of Epsom and the neighbourhood has produced a very useful little book.

The flora, which includes a good map of the district, is the outcome of observations made between the years 1889 and 1914 by Mr. Hart Smith-Pearse and masters and other members of the Epsom College Literary and Scientific Society. The account suffers a little, no doubt, owing to the absence of records during school vacations in April and August, not so much in the omission of plants, perhaps, as in the records of the first flowering of certain species.

These records of the earliest and latest dates of flowering are a valuable addition to the flora, and a particular feature of the natural history work, both at Marlborough and Epsom.

The London Catalogue is followed as regards specific names and the numbering of the orders and genera, and in comparison with the Catalogue for 1908, it is noted that twelve orders and 184 genera are not represented in the flora.

The interest of the book is enhanced by the attempt which has been made to give the derivation of each generic name. It is unfortunate that in the case of names from the Greek, the Greek word is not given as a guide to the pronunciation. The author has, however, taken care to accent all the names, and we hope that some day the proper pronunciation of cle'matis will become general.

As to Fumaria, we believe the name to have been used with reference to the resemblance of the grey-leaved plants to smoke issuing from ground, rather than to the smell of the plants. Certainly the old authors referred to the fumitory as *fuma terrae*.

The study of natural history as fostered by the Rev. T. N. Hart Smith-Pearse, both at Marlborough and Epsom, is of the utmost value, as boys who have learnt how to observe, thanks to the traditions he has established, well realise. As an old Marlburian, the writer fully agrees that field botany, properly studied, will not fail to bear fruit in after years. "It is," as the author says in his preface, "a branch of education which it is foolish to neglect, for it may often lead a boy to find his true career, and seldom fails to add to his future happiness and enjoyment." A. W. H.

Transmission Gears, Mechanical, Electric, and Hydraulic, for Land and Marine Purposes. By E. Butler. Pp. xii+164. (London: Charles Griffin and Co., Ltd., 1917.) Price 8*s.* 6*d.* net.

THIS book is intended for engineers engaged in the application of internal-combustion engines for automobile, marine, and other purposes, and provides a fairly exhaustive treatment of friction-clutches, change-speed gears, and reversing methods. The book contains a large number of illustrations taken from working drawings; these drawings, together with the accompanying descriptions, constitute the most valuable part of the work, and should be very useful from the designer's point of view. The author is by no means so happy in the sections introducing calculations, and in some parts has produced so much confusion as to render these portions almost unreadable. Thus the terms "torque" and "driving effort" have entirely different meanings, but the author uses them indiscriminately in his calculations on friction-clutches. The result is that there are many errors in this section of the book, which should be revised thoroughly in the second edition. Further, calculations which "run on" in the text are difficult to follow; these are much more likely to be read and understood if displayed properly. There is also need for the introduction of clear methods of calculating epicyclic gears; those given are not likely to be of much assistance to the designer. As stated above, the value of the book consists in its collection of working drawings, and its value could be greatly enhanced by thorough revision.

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.*]

Construction for an Approximate Quadrature of the Circle.

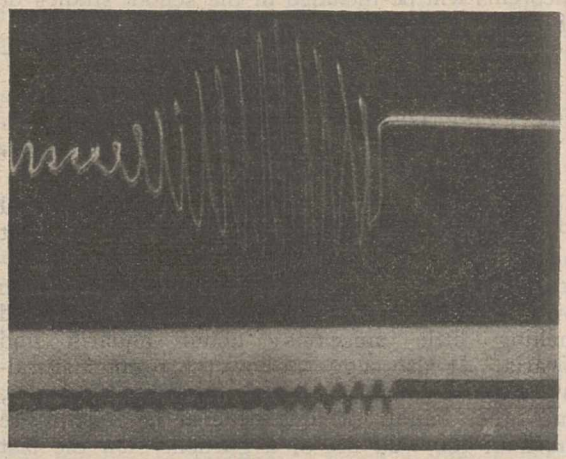
DR. ROUSE BALL'S interesting account, in NATURE of May 23, of M. de Pulligny's constructions reminds me of another simple one which I do not think known. If OA, OB are perpendicular radii of a circle of radius 1, and if BCD is a line cutting OA in C and the circle in D and representing the side of the square in question, then $OC=\sqrt{(4/\pi-1)}=0{\cdot}52272321$, which, put into the form of a continued fraction, has for convergents $\frac{1}{2}$, $\frac{11}{21}$, $\frac{12}{23}$, $\frac{23}{44}$, $\frac{2919}{5586}$, etc. The convergent $\frac{23}{44}$, or 0·52272727, differs (in excess) from the real magnitude only by 1 in .128750; hence if we take C such that $OC=\frac{23}{44}OA$, which can be done easily and with great accuracy, the line BCD represents the required side with all the accuracy which any graphic construction can be expected to give. Theoretically, this method is 121 times more accurate than M. de Pulligny's construction with the Archimedes ratio, but thirty-seven times less accurate than that with the Metius ratio. In practice, however, this relative inaccuracy is absolutely unnoticeable, and the method here described is the easier to carry out.

ROBERT E. BAYNES.

Christ Church, Oxford.

The "Wolf-note" in Pizzicato Playing.

THE accompanying photograph, showing the simultaneous vibration curves of the G string and bridge of a 'cello played *pizzicato* at the "wolf-note" pitch, presents some noteworthy features which may be of interest to readers of NATURE. One of the striking features is the extremely rapid dissipation of energy. The other feature is the effect of the motion of the bridge on the vibration of the string. The photograph may, in fact, be briefly described as showing a strongly



damped *coupled* vibration of the string and bridge, in many respects differing from the cyclical vibrations excited by *bowing* at the "wolf-note" pitch described by me in previous communications to NATURE. At pitches slightly different from that of the "wolf-note," the dissipation of energy is far less rapid, and the motion of the string approximates to that of an ordinary damped harmonic vibration.

C. V. RAMAN.

Calcutta, April 12.

The "Hay-box" Principle in Cooking.

IT happened last week that about 1 lb. of fresh lamb was put into an oven at night in order that it might be cooked by morning on the "hay-box" principle. It was in a casserole, with a little water. Similar treatment in the same oven on previous occasions had been very successful. At about 5 a.m. the casserole was examined, and the broth was found to be very well tasted, and the whole smelt fresh and good, but the meat when tested with a fork was not tender, and the fat (of which there was a good deal) was *entirely* unmelted. The casserole was returned to the oven (then quite cool) and taken out again after breakfast. The contents were then found to be smelling most offensively, as if extremely "high." The fat was melted. The meat and broth were judged quite unfit for human food.

I wonder if any of your readers would explain this curious development.

AN INQUIRER.

May 30.

British Oligochæt Worms.

I AM now engaged on the MS. of my monograph of British Oligochæts for the Ray Society. The first volume will be devoted to the Enchytræids or white-worms. Though the country has been well worked, no doubt there still remain indigenous species which have not yet been recorded; and I shall be glad to aid other workers in making them known.

HILDERIC FRIEND.

Cathay, Solihull, Birmingham.

THE POSITION OF NATURAL SCIENCE IN THE EDUCATIONAL SYSTEM OF GREAT BRITAIN.

THE report of the Committee appointed by Mr. Asquith when Prime Minister in August, 1916, has recently been issued, and a summary of its conclusions appeared in NATURE for April 18. The chairman of the Committee was Sir Joseph J. Thomson, president of the Royal Society, and now Master of Trinity College, Cambridge. In an article on the report the *Times* hinted that the Committee included too large a proportion of men of science to yield conclusions entirely free from bias. There is no justification for such suspicion. The report was unanimous. Apart from members representing industry and business, and several with large experience of educational organisation, not fewer than six possessed a practical acquaintance with teaching, acquired as masters in public schools; and one of these, now a headmaster, was formerly a classical master at Clifton.

Whatever view the reader may take of the questions involved in the business of the Committee, he will find that the introduction to the report contains interesting reading and expressions of sentiment in reference to the value of literary and historical studies which ought to be satisfactory to every reasonable person. There is no sign of prejudice here. But there is probably no department of human activity in which it is more difficult to bring about a change of opinion than in connection with education. It is more than a century since the Rev. Sydney Smith poured the burning satire characteristic of his wit on the classical pedantry of his day, which forbade the mere mention of such subjects as political economy, much less the various divisions of physical science, as worthy of notice in a university. It is more than fifty years since the Duke of Devonshire's Commission recommended that all boys should receive instruction in some branch of natural science. Nevertheless, while undoubtedly great advances have been made of late years, it is even now impossible to say that all the secondary schools in the country are free from the prejudicial influence of the exclusively literary form of education in which the majority of schoolmasters have been brought up. There is too much of the attitude of the young man in the parable who said to his father, "I go, sir," and went not. There are great schools still which boast that they are teaching science, while their pretensions are shown to be hollow by the totally inadequate allowance of time assigned by them to science subjects, and by the fact that many of the literary specialists among the boys escape altogether.

Just now, as remarked by the Committee, the war has led the nation to perceive something of its deficiencies in the matter of science, and everyone is ready to receive science with open arms. "Just now it seems unnecessary to take action to ensure against any relapse into the old conditions, but experience of the past shows us that temporary enthusiasm needs to be fortified by some more binding material."

What, then, ought to be done? The Committee has provided a summary of the principal conclusions. These conclusions are gathered into eighty-three short paragraphs. They are obviously not all of equal importance, and, of course, they apply to various kinds of school and to the needs of various callings.

First and foremost the recommendations that all schools should be subject to compulsory inspection, and that this inspection should be under the direction of the State, will find few to raise objections. The work need not be done wholly by inspectors from Whitehall, for the universities, more numerous and active than formerly, have already considerable experience in this direction. And it is only when a little light is thrown into the dark places and a little pressure put on that governing bodies and headmasters will see what is their duty in this connection. This consideration suggests another reform which is not referred to by the Committee, and that is the desirability of some control of the constitution of governing bodies of schools. In some cases local tradesmen are put on with the object of representing ratepayers who object to the cost of education. In other cases the vicar of the parish is a member and often the chairman of governors, no matter what his qualifications for dealing with educational matters. Others, again, notably some of the most famous schools, are under the control of bodies containing far too large a proportion of clerical members, whose attitude towards science is for the most part as conservative as it was forty years ago.

The report is emphatic in the conclusion that more time must be given to science in all schools, for girls as well as for boys. At the present time and for some period after the war there is a practical difficulty about carrying this into effect, owing to the scarcity of teachers. But this will have to be altered by making the profession more attractive both in regard to salary, prospects, and pension, and, as pointed out by the Committee, in the attitude of the public towards the use of education and the importance of the training of teachers. Every teacher agrees that lessons in natural science are effective only when the pupil is required to do some kind of practical work for himself—that is, to handle materials and make observations and experiments on them. For this purpose a room must be set apart which provides plenty of light, a water supply of a suitable kind, convenient methods of applying heat, and so forth. It must also be furnished with some apparatus, especially balances for weighing. In fine, what is commonly called a laboratory must be provided. Fifty years ago or later a few great schools had their laboratories, plainly though sufficiently equipped. Now some of these schools have run into what must be regarded as extravagance in this direction. Their

laboratories are fitted with every modern convenience, and are equal in elaboration to anything which might be expected in a university. The idea of providing labour-saving appliances may be carried too far in the laboratories to be occupied by junior students. When everything is "laid on" and it is only necessary to turn a tap, opportunities for the exercise of ingenuity and dexterity, as well as the acquisition of useful practical knowledge, are lost. The young student should be encouraged to make many things for himself, starting with glass and rubber tubing, wire, sealing wax, etc.

The provision of school laboratories has gone on very rapidly during the last twenty years, and it is probably in girls' schools chiefly that it is least satisfactory. The Committee very wisely points out that in planning new schools it is much more important to secure ample space than to provide elaborate and costly fittings. There is a large number of private schools, chiefly for preparatory and cramming purposes, which have no provision for practical work, and how to deal with these people is not very clear while the parents are so ignorant and display so much indifference. A proper inspection system would probably have the effect of squeezing some of them to death, which would on the whole be an advantage to the country.

One other point may be mentioned relating, not directly to the pupils, but to the teachers. While it is certainly necessary to hold out to the teaching profession more liberal inducements to take up this kind of work, a higher standard of efficiency will reasonably be demanded of teachers. The Committee recommends that short courses of training should be established for teachers, which apparently they think should be taken concurrently with other studies, and not at the end of their course. This recommendation ought undoubtedly to be adopted by all who propose to become teachers in schools where the students are all beginners. A young man or woman may be full of knowledge without the least idea of the best way to reach young minds, and a few months devoted to the study of method will be found advantageous to everyone. The prospective teacher may have attended the systematic course of a professor at the university, but he ought not to proceed to imitate this in his dealings with boys and girls. At the same time, he ought to be cautioned against faddists and educational quack doctors, but should be led to examine his own stock of knowledge and experience, and ask himself how best he can make it attractive and useful to others. After one or two experiments each one will find out for himself how best to accomplish this, and to awaken in others an interest in the subject taught. Some freedom in this process ought to be allowed by headmasters and inspectors. Very valuable work in the way of suggestions to teachers of various subjects, both physical and biological, has been accomplished by the Association of Public-School Science Masters and the corresponding Association of Science Mistresses, and attendance at the annual meetings of these bodies, which would probably be open to non-members, would be certain to be full of interest and instruction to young teachers. W. A. T.

SCIENCE AND ADMINISTRATION.

THE growth in the magnitude and in the complexity of modern industrial and commercial undertakings has in recent years caused attention to be directed to the methods of management in connection therewith, and a vast amount of knowledge on the subject has been accumulated, co-ordinated, and arranged. In consequence, a great volume of literature, constituting the science of administration, has been brought into existence. To this an interesting addition has very recently been made by the publication in the number for the first quarter of 1918 of the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale* of a paper read by M. Fayol on November 24, 1917, in Paris on "L'importance de la Fonction Administrative dans le Gouvernement des Affaires." We learn therein that the Société des Ingénieurs civils de France has recently made a strong recommendation that courses of instruction on "administration" shall be introduced forthwith into all the higher schools of civil engineering in France. M. Fayol, on the occasion mentioned, expressed a hope that instruction in this subject might be made part of the curriculum of every school in France, even a part of those of primary schools; he is convinced that widespread instruction in "administration" must result in immense benefit to the French nation.

A knowledge of scientific methods of administration and the application of the principles thereof in the domain of private undertakings, as well as in that of State enterprises, are matters which possess the same importance in these islands as they do in any other part of the world. There is reason to believe that this is fully appreciated in our business circles, and to this is it due that, at centres where courses of instruction are given in subjects connected with "administration," those responsible for the conduct of important undertakings encourage their employés to attend such courses, and even give them facilities for the purpose. But, unfortunately, a similar attitude does not prevail in our Government circles. Not so many years ago the head of one of the branches of a Government Department put forward proposals in connection with the institution of special courses of instruction in administrative subjects for the officers of his branch. The Minister in charge of the Department received the suggestion sympathetically; the officials of the London School of Economics were accommodating and took great pains in preparing a scheme for the purpose; however, the permanent officials of the Department were passively hostile. The subject remained

under discussion for a very considerable time, but eventually was allowed to drop. Naturally, no official reason was given why the proposal met with such a fate; possibly the permanent officials were opposed thereto for the reason that, in their opinion, the institution of the proposed courses would have made the branch in question "too strong"—that is to say, *too efficient*.

It would almost appear as if the attempt to attain such a result in the public services was regarded as a most reprehensible act. Yet it must be evident that, before scientific methods can be put into practice, such methods must be learnt and understood; also that individuals in the public services are no more capable of acquiring such knowledge by mere intuition than are those employed in civil life. Further, it is generally recognised that the days have long gone by when boldness in enterprise can make up for the lack of systematised knowledge and method, whether in the industries and in commerce, or in the domain of State activity, in diplomacy and in war.

The science of administration is concerned alone with those lessons which teach how the highest state of efficiency can be secured in the enterprises with which men busy themselves; the principles involved therein lie, as M. Fayol reminds us, within a narrow compass. "Administration" is neither an exclusive privilege nor a personal quality of those controlling or managing an undertaking or enterprise; it is really a function which, like all essential functions, comes into play between the head and the members of a body corporate. It must be distinguished from management, which is a *rôle* concerned with the care and skilful conduct of the whole of an enterprise, a *rôle* that must provide for the efficient performance of the following essential functions—namely, the administrative, technical, commercial, financial, that of custodianship and that of book-keeping.

Although "administration" is only one among the above six functions, nevertheless it demands that foresight, efficient organisation, co-ordination, and control shall prevail throughout the enterprise or undertaking, and it comes into play not only in the enterprise or undertaking as a whole, but also in every part and in every operation thereof.

Most powerful aids to efficient administration exist in "Taylorism" and in a sound organisation within the enterprise or undertaking; the former concerns the "science of efficiency" in relation to the individual; the latter concerns the same "science" in relation to the body corporate.

"Taylorism," or *chronométrage*,[1] consists in the determination of factorial values in time units for each item of the work of individuals when performed in the most efficient manner human beings are capable of. Such values can be ascertained in relation to every branch and item of human activity, and, when properly applied, afford an unsurpassable check, of a preventive and anticipatory order, against waste of human effort.

Organisation consists in the proper subdivision of the work of an enterprise and in the most effective employment of the *personnel* necessary to carry it on. The principles involved are few in number, but no single uniform organisation can be devised which will suit the varying requirements of every undertaking: each must be provided with an organisation specially designed in relation to the nature of the operations that have to be conducted therein.

In the case of private undertakings the instinct of self-preservation is an impelling force, and, in consequence, they are, as a rule, provided with a sound and efficient organisation. On the other hand, in the case of the public services artificial conditions, as a rule, prevail, and the question of the survival of the fittest is not a troubling factor; in consequence, State undertakings are often provided with an illogical or unsound organisation.

Strange indeed are the ways of political reformers who concern themselves with State organisation and administration. In recent years, by a curious irony, struggles were started about the same time of a nature that whereas one State, which possessed an admirable organisation, might have been seen attempting to abandon the same for one less efficient, another State, which had become tired of inefficient methods, might, on the other hand, have been seen endeavouring simultaneously to introduce industrial conditions into its public services; these struggles were witnessed, in 1912, in Sweden and Italy, and arose in consequence of the reports of Royal Commissions.[2]

Sweden, at that time, possessed an old-established organisation in its public services—one that was brought into existence, in 1634, by that great administrator, Oxenstierna, who had fixed with precision the powers of the great Departments of the Swedish Government and had vested the management of State undertakings in Administrative Boards, whereon both technical and administrative officials serve. Even the Commission that recommended changes in the well-tried State organisation of Sweden—changes which are, in the opinion of the well-informed, likely to introduce a bureaucratic encumbrance and political mismanagement in Swedish State undertakings of a technical character—has spoken favourably in its report of these Boards: it has stated that the independent position occupied by the Administrative Boards has in the past proved a considerable safeguard and had acted as a powerful element in contributing to the smooth working of the State machinery, whilst providing a powerful incentive towards progressive ideas.

Italy, on the other hand, at the period in question possessed an organisation in its public services scarce half a century old, an organisation which

[1] The invention of Mr. F. Winslow Taylor, of the Bethlehem Steel Co., U.S.A.

[2] (1) "Departementalkommitterades Betänkande." (Stockholm: H. L. Beckman's Boktryckeri, 1912.) (2) "Commissione Reale per lo Studio Technico, Amministrativo e Finanzario del Servizio Telefonico in Italia." (Rome: Tipografia dell' Unione Editrice, 1911.) (3) "Commissione Reale per il Riordinamento dei Servizi Postali e Telegrafici." (Rome: Tipografia ditta Ludovico Cecchini, 1912.)

suffered from the exigencies of political jurisdiction and, to some extent, from the mischief of bureaucratic control. At Rome, too, policy and technical Boards were in existence in connection with the public services, but these Boards occupied only a consultative position. Italy, in the struggle mentioned, was desirous of emancipating its public services of a technical nature from political influences and the incubus of bureaucracy, and substituting therefor an industrial organisation and commercial methods of administration.

It is not surprising, then, that M. Fayol should have told the Paris audience to whom he addressed himself in November last that only those who possess technical and administrative ability combined are really capable of laying down scientific methods of administration and of erecting the framework of a scientific organisation. No practical person familiar with the requirements of modern technical enterprises is likely to quarrel with him for holding this view. It must be evident even to the most casual observer that we have now reached a stage in industrial development such that, in order to obtain the fullest measure of success from human effort, it has become imperatively necessary to secure from men possessing scientific attainments and a technical training the highest degree of co-operation in the administration and management of technical enterprises, whether privately owned or in the hands of the State; further, that any attempt to divorce the administrative from the technical control in such enterprises is mischievous, and must, if persisted in, eventually lead to national ruin.

W. A. J. O'MEARA.

AFTER THE WAR.

THE final report of the Committee on Commercial and Industrial Policy after the War has now been issued; it necessarily deals with such a vast number of complex subjects that it has perforce to content itself with generalities, more or less vague, and gives but few indications upon which any definite line of policy can be based. It is notably weak in what should, perhaps, have been its most important inquiry—namely, as to the utilisation of the natural resources of the Empire to the best advantage in the future; it is significant that the title of the Committee is "on Commercial and Industrial Policy," instead of "on Industrial and Commercial Policy," as it logically should have been, seeing that a sound commercial policy can only be developed upon lines following industrial development, and not *vice versa*.

In most cases this Committee has merely summarised the reports of various Departmental Committees, without giving any indication of the relative importance of the subjects discussed. For example, the coal trade is thus briefly dealt with, and there is no indication in the report to what an overwhelming extent this is the essential industry upon which our Empire depends. Mr. Scoby Smith has, indeed, appended a very valuable note upon the importance of conserving our supply of coking coal, but even this does not touch the larger question. Coal plays, in fact, a two-fold part; not only is it the raw material from which a host of important industrial and pharmaceutical products may be obtained, but, above all and beyond all, it is also practically the sole source from which we draw our mechanical energy. Without a continuance of the supply of abundant and relatively cheaply won coal that we have hitherto enjoyed, the industrial supremacy of Britain would be gone, and we should rapidly fall to a very subordinate position amongst nations. It is scarcely too much to say that the magnitude of this problem completely overshadows all the others; if the whole of the recommendations put forward by the Committee could be acted upon, and if they all produced the maximum of good effect that the most sanguine member of the Committee could expect, they would be powerless to save Great Britain from industrial ruin if she could no longer produce an abundant output of coal as cheaply as her competitors. The Committee does not appear to have realised that such coal production is the most urgent and the most vital of all after-the-war problems.

There are, it is true, some recommendations as to mineral production in general which naturally do include our coal production. Thus the Committee strongly recommends an intelligence and advisory bureau for dealing with metals and minerals, and a special letter from the chairman of the Committee to the Premier emphasises this recommendation, and supports the resolution of the Imperial War Conference to the effect that an Imperial mineral resources bureau should be established in London. It is satisfactory to know that such a bureau is in process of formation, and the general tenor of the Committee's views on the subject would seem to be quite sound, especially in respect of the principle which is laid down—that the functions of the bureau should be the dissemination of intelligence and advice, but be in no sense executive; and, further, that the utmost use should be made of the services of technical and scientific experts. The value of such a bureau to the mineral industries of the Empire should be very great, and its suggested activities are exactly what is required; hitherto the assistance that the coal-mining industry has received from the Governmental authorities has been essentially of the negative order.

Our mining engineers can be trusted to work out their own problems for themselves, as they have always done, but the increasing complexity of mining methods demands a far better supply of official information than has been forthcoming up to the present. It is only necessary to compare our meagre Home Office annual reports with the splendid volumes of the Prussian *Zeitschriften* to realise how greatly we have been handicapped in this respect. Of all national resources, mineral resources need the most scientific study, the most complete utilisation, and the most careful conservation, because, unlike other natural resources, they are not reproductive, and, once used, they

can never be renewed. On all grounds the creation of such a bureau as has been advocated by the Committee is to be heartily welcomed by the mining community, and it ought to play a leading part in co-ordinating the utilisation of our mineral resources after the war to the best advantage.

It is doubtful whether other recommendations are likely to be quite so successful in every case, and in some instances they scarcely appear to have been sufficiently thought out. Thus one of the suggestions is the creation of a statutory tribunal to enforce the granting of wayleaves where unreasonably withheld. There is no doubt that wayleaves do in many cases press unduly and unfairly upon the mineral producer, but the proper remedy is a modification of the whole system rather than a palliative to be applied only to cases where wayleaves are refused. At present any landowner is at liberty to make whatever charge he thinks fit for a mineral wayleave across his land, and his method is to base his charges upon the presumed needs of the miner. A simple legislative enactment that the measure of a wayleave rental should be, not the necessity of the miner, but the amount of damage suffered by the landowner, is really what is required. There would be no difficulty in finding a tribunal capable of properly assessing such damage, and it cannot be fairly urged that such a system would be inequitable. Again, whilst the Committee has devoted some attention to the question of taxation, it has failed to note how unfairly the present methods press upon the mineral industry, inasmuch as in levying income-tax no regard is given to the fact that a mine or a mineral property is necessarily a wasting asset, and that what is, in fact, to-day taxed as profit derived from the working of minerals is not all profit, but represents as to a portion of it a return of the capital invested. The only recommendation made on the very important matter of allowances for depreciation for income-tax purposes is that it should be "on an adequate scale"; the Committee does not appear to recognise that the principle of calculating depreciation upon the diminishing value of machinery and plant is wrong, and that the entire subject needs revision in the light of modern industrial methods.

As regards the supplies of ores, both of the ferrous and non-ferrous metals, the present report does not advance in any way upon the reports of the respective Departmental Committees, except in so far as they would receive much valuable assistance from the Imperial bureau of mineral resources. It need scarcely be said that the report contains a vast amount of valuable information, and will well repay attentive perusal; nevertheless, the special aspect of the whole subject, to which attention is here devoted—namely, the future development of the mineral resources of the Empire—has not received the share of consideration to which its pre-eminent importance entitles it. This was, perhaps, inevitable, having regard to the constitution of the Committee and the wide range of its inquiries; but it is none the less to be regretted.

H. LOUIS.

NOTES.

THE long list of honours announced on Monday, for war and other services, in celebration of the King's birthday, includes the names of the following workers in scientific fields:—*G.C.V.O.*: Sir Alfred Keogh. *K.C.M.G.*: Sir William Leishman, F.R.S. *K.C.S.I.*: Sir Thomas Holland, F.R.S. *C.I.E.*: Lt.-Col. E. A. R. Newman, Indian Medical Service, superintendent, Medical School, Dacca, Bengal; Mr. J. R. Henderson, superintendent, Government Museum; Mr. C. A. Barber, Agricultural Service, Imperial sugar-cane expert, Madras. *K.C.B.*: Surg.-Gen. H. D. Rolleston. *C.B.*: Sir Hugh Bell, Bart. *K.C.M.G.*: Prof. John Cadman. *C.M.G.*: Prof. H. L. Ferguson, professor of ophthamology, University of Otago. *Knights*: Mr. Harry Baldwin, for services as dental surgeon to his Majesty for a number of years, and as head of the Kennington Facial Hospital; Mr. C. H. Burge, late departmental principal of the Government Laboratory; Mr. Mayo Robson, past vice-president of the Royal College of Surgeons; and Dr. E. D. Ross, principal of the School of Oriental Studies.

THE British Science Guild is organising a comprehensive exhibition of products and appliances of scientific and industrial interest which prior to the war were obtained chiefly from enemy countries but are now produced in the United Kingdom. His Majesty the King has graciously consented to become patron of the exhibition, and the Marquess of Crewe, K.G., is president. Among the vice-presidents are the Prime Minister; Mr. Winston Churchill, Minister of Munitions; Sir Albert Stanley, President of the Board of Trade; Mr. H. A. L. Fisher, President of the Board of Education; Dr. Addison, Minister of Reconstruction; Lord Moulton; Lord Rayleigh; Lord Sydenham; Sir J. J. Thomson, president of the Royal Society; Sir Norman Lockyer, and Sir William Mather. The exhibition, which will be held at King's College from about the first week in August until the first week in September, will show, in the first place, products chiefly imported from Germany before the war, but now made in this country; and it will also illustrate the remarkable developments that have taken place generally in our scientific industries. In many of these, as a matter of fact, Great Britain always excelled, and it is only our national quality of self-depreciation which has prevented the public from appreciating the fact that we were able to export to Germany apparatus and products embodying the highest scientific knowledge and technical skill. The general scope of the exhibition has been set forth in a preliminary leaflet which has been issued, from which it is noted that the exhibits will include chemical products, thermal, electrical, and optical appliances, glass, quartz, and refractory material, photographic apparatus and material, surgical and medical appliances, and papers and textile products. It is believed that the exhibition will have a most stimulating influence upon scientific and industrial research, and the exhibits, with the demonstrations and lectures that will be given in order to explain them, will undoubtedly bring home to manufacturers, as well as to the general public, the great and growing part that science plays in industry. Further particulars may be obtained from the Organising Secretary, 82 Victoria Street, London, S.W.1.

THE KING AND QUEEN gave a small dinner-party at Buckingham Palace on Tuesday night, at which the guests included Sir Joseph Thomson, president of the Royal Society, and Lady Thomson, and Sir Frederic Kenyon, president of the British Academy, and Lady Kenyon.

THE Geological Society of France has awarded this year's Gaudry medal to Prof. H. F. Osborn, of the American Museum of Natural History.

THE family of the late Dr. George J. Hinde has presented to the Geological Department of the British Museum (Natural History) his collection of fossils, with numerous microscopic preparations illustrating his researches on radiolaria, sponges, and other small organisms. Most of the fossils were collected by Dr. Hinde himself from the Palæozoic formations of Canada, the United States, and Sweden.

THE Wilbur Wright memorial lecture of the Aeronautical Society will be delivered in the Central Hall, Westminster, on Tuesday, June 25, at 8 o'clock, by Prof. W. F. Durand, chairman of the American Advisory Committee for Aeronautics, Scientific Attaché to the American Aviation Mission in Europe, and professor of mechanical engineering, Stanford University, U.S.A. The subject will be "Some Outstanding Problems in Aeronautics."

THE second reading of the Coinage (Decimal System) Bill was moved by Lord Southwark in the House of Lords on Tuesday, June 4. Lord Leverhulme opposed the motion, though he was not against the principle of decimal coinage. He objected to making the sovereign the unit and dividing it into one thousand parts, and he thought that a British decimal system of coinage should be based upon the halfpenny. After discussion, the debate was adjourned on the understanding that the Government will institute an inquiry into the whole question of decimal coinage, including the proposals contained in Lord Southwark's Bill.

WE learn from *Science* that Dr. Ferdinand Braun, who shared the Nobel prize in 1909 with Mr. Marconi for distinguished achievements in the invention of improved methods of wireless telegraphy, died on April 14 at a Brooklyn hospital. Dr. Braun was born in Fulda, Germany, in 1850, and was professor of physics in the University of Strassburg, when he went to the United States in 1914 as a witness in litigation between the Marconi Wireless Co. and the German company which built and operated the wireless station at Sayville, L. I.

A MYSTERIOUS epidemic has made its appearance in Madrid, and is stated already to have claimed more than 100,000 victims. In offices, factories, and schools some 30 to 40 per cent. of the inmates have been attacked, and all classes of the community are affected. The disease commences suddenly with severe headache, followed by high fever, throat irritation, some bronchitis, muscular and joint pains, gastric disturbance, and depression and debility; these symptoms last for three to four days, and then convalescence commences. At first the disease was quite benign, but now is fatal to a certain proportion of debilitated subjects. According to a correspondent of the *Times*, there were more than 700 fatal cases in the ten days ending June 2. The disease in many respects resembles influenza, but the influenza bacillus has not been found. A meningococcus-like microbe, termed a para-meningococcus, has been isolated.

THE Inter-Allied Scientific Food Commission, which has met in Paris and Rome, is now holding a meeting in London. The Commission consists of two scientific delegates from each of the four countries—America, England, France, and Italy—and one from Belgium. The object of the Commission is to consider all questions affecting the supply of food to the various Allied countries, in agreement with the Allied Food Executives (which determine the division of food among the Allies), and to make what recommendations it thinks advisable to the respective Governments. At the first two meetings certain physiological principles were established, such as the amount of food necessary for each man, and, as a result, the amount of food necessary for each country. The question with which the Commission is now concerned is the making of a census of the production of foodstuffs in each country. The members of the Commission will attend the meeting of the Royal Society to be held to-day, when it is hoped that as many fellows as possible will be present to meet them.

THE Food Investigation Board of the Department of Scientific and Industrial Research has appointed a committee to inquire into the present methods of freezing, storing, and preserving fish, and to conduct experiments directed towards the improvement of existing methods. The constitution of the committee is as follows:—Mr. H. G. Maurice (chairman), Board of Agriculture and Fisheries; Prof. W. M. Bayliss, professor of physiology, University of London; Prof. J. Stanley Gardiner, professor of zoology, Cambridge; Mr. Crawford Heron, Swansea; Prof. F. Gowland Hopkins, professor of biochemistry, Cambridge; Mr. W. J. Howard, Ministry of Food; Mr. Douglas Johnstone, Ministry of Food; Staff Paymaster Jones, Fishery Board for Scotland; Prof. J. C. McLennan, professor of physics, University of Toronto; Prof. G. H. F. Nuttall, Quick professor biology, Cambridge; Sir Thomas Robinson, Grimsby; ex-Provost Malcolm Smith, Fishery Board for Scotland; Mr. J. M. Tabor, Peninsular House, E.C.3; Mr. H. J. Ward, Dartford Iron Works, Kent; and Mr. E. Warner, National Fish, Poultry, Game, and Rabbit Association, Leicester, with Capt. L. H. James as secretary. All communications intended for the committee should be addressed to the Secretary, Fish Preservation Committee, at 43 Parliament Street, London, S.W.1.

THE sixteenth annual meeting of the South African Association for the Advancement of Science will be held in Johannesburg on July 8–13, under the presidency of Dr. C. F. Juritz. The presidents of the sectional committees will be as follows:—Section A, Astronomy, Mathematics, Physics, Meteorology, Geodesy, Surveying, Engineering, Architecture, and Irrigation: Prof. J. T. Morrison. Section B, Chemistry, Geology, Metallurgy, Mineralogy, and Geography: Dr. P. A. Wagner. Section C, Botany, Bacteriology, Agriculture, and Forestry: Mr. C. E. Legat. Section D, Zoology, Physiology, Hygiene, and Sanitary Science: Prof. E. J. Goddard. Section E, Anthropology, Ethnology, Native Education, Philology, and Native Sociology: Rev. W. A. Norton. Section F, Education, History, Mental Science, Political Economy, General Sociology, and Statistics: Prof. T. M. Forsyth.

As is well known, German dirigibles are equipped with wireless, but there has always been a certain amount of speculation as to how the scarcely perceptible signals can be heard in the midst of the noise due to the motors and the displacement of the air. According to a German technical publication (quoted in *La Nature*, May 25), a special method is in use. The high-frequency oscillations of the receiving station act on an Einthoven galvanometer. The plant recalls the prismatic sight. Underneath is a small electric lamp, the light of which falls on a narrow slit, ordinarily covered by the galvanometer string. The string is in an intense magnetic field. When the receiving current passes, the string deviates, thus

allowing the luminous ray to be perceived. The observer at the sighting device can thus read the signals transmitted, in dots and dashes, in the form of short or long light-rays projected by the illuminated slit.

THE Leeds automatic telephone exchange, which was opened on May 18, is the largest automatic exchange in Europe. Sir William Slingo, the head engineer of the Post Office, was one of the first to recognise that the manual operators in an exchange will ultimately have to be replaced by automatic devices. The longer the development is delayed, the more capital will be lost when the manual exchanges have to be scrapped. The Post Office has been criticised for carrying on the work in war-time, but the need was urgent, and, besides, the manual instruments displaced at Leeds were most useful for war service at the front. The Leeds exchange is equipped for 6800 subscribers, but it will ultimately have a capacity for 15,000. It represents the very latest developments in automatic working. A storage battery in the exchange supplies the energy required for the working of all the switches. The definite and accurate working of all the necessary switches when any subscriber takes his telephone off the hook and operates his dial is perfect. When the "called" subscriber is engaged the "busy back" signal is sent automatically, and the subscriber has to wait before he calls again. As there are 26,000 wires entering the building, the arrangement of all the connections is a marvel of ingenuity. The Post Office has several other automatic exchanges in this country. The next largest is at Portsmouth, which has 5000 subscribers already connected and an ultimate capacity of 7000.

IN a recent letter to the *Times* (May 27) the Duke of Montrose pleads for moderation in the destruction of rooks. His lordship has examined thirty gizzards of birds shot between April 1 and May 31, twenty of which contained worms and grubs, six had grains of oats and other matter, one beetles and worms, and one horse-manure and grit. The fallacy, however, of judging of a bird's feeding habits by examining the food content of the stomach during certain periods of the year has frequently been dwelt upon, and just as in this case it would lead the uninitiated to pronounce a verdict in its favour, in regard to other species it would lead us to condemn undoubtedly beneficial species. Whilst not wishing to see the rook exterminated, experience shows that it certainly requires reducing in numbers. An investigation, now extending over four years, on the food of the rook, during which period upwards of 2000 birds have been examined, shows that of the total food eaten in a year, 35·1 per cent. consists of cereals, 13·4 of potatoes and roots, 6·1 of miscellaneous vegetable matter, 4·4 of weed seeds, 23·9 of injurious insects, 3·5 of beneficial insects, 4·6 of neutral insects, 3·2 of slugs and snails, 4·4 of earthworms, and 1·4 of eggs, mice, etc. In other words, 52 per cent. of the rook's food is injurious, 19·5 neutral, and 28·5 beneficial. It is, therefore, impossible to ignore the fact that at present this bird does considerably more harm than good, and that there is now overwhelming evidence to this effect which it would be foolish for the farmer to ignore.

SPRING has closed with a burst of brilliantly fine weather, and May almost throughout maintained its usual characteristic of fickleness. The first half of the month was cooler and the rainfall was generally heavier than in the latter part of the month. At the commencement of May the cold was greatest in Scotland, the weekly weather report, ending May 4, showing the deficiency of temperature to be 4° F. in Scotland E.; at Greenwich the deficiency was only 1·4°. For the week ending May 11 the temperature was not very different from the normal in any part of the British Isles, and at Greenwich there was an excess of 1·6° F. For the week ending May 18 temperature had an excess of 5·3° at Greenwich, and for the week ending May 25 an excess of 6·2°. The highest temperature at Greenwich was 83° on May 21, whilst at Camden Square the thermometer registered 88°, and at Tulse Hill 87°. At the latter station the mean temperature for May was 58°, the mean maximum was 68°, and the mean minimum 48°. The mean maximum temperature for May 1 to 15 was 62°, and the mean maximum for May 16 to 31 74°, whilst the mean minimum was respectively 46° and 51°. Temperature this year in May is nearly as high as last year, and is about 4° above the normal. An absolute maximum of 83° has frequently been beaten for May at Greenwich, but there has been no record as high as 88°.

WE have received from the Rev. S. Graham Brade-Birks descriptions of a curious cloud effect which he has observed over Darwen Moor, Lancashire, the point of observation being in the town of Darwen, to the east of the moor. The effect consisted of a thin stratum of cloud which appeared to run parallel to the contour of the hill of the moor for a considerable distance from south to north. The cloud was noticed on two separate occasions, viz. on May 6, at 9.30 p.m., and on May 17, at 10·15 p.m., summer time. On the first occasion the sky was otherwise cloudless; on the second the stratum of cloud was superimposed upon a background of cumulo-nimbus cloud, in the western sky, from which rain afterwards fell. On both occasions there was a light N.W. or W.N.W. wind at the surface at 10 p.m., summer time, which had succeeded a light or moderate S.S.E. wind at 10 a.m. The weather-maps for the two occasions present some points of similarity. On May 6 Darwen was situated in the col or "saddle" between two "highs" and two "lows"; on May 17 it was in the corner of a north-easterly extension of an anticyclone—that is, just on the high side of a "saddle." In such circumstances pilot-balloon observations have frequently revealed the existence of two distinct currents of air superimposed one upon the other, one current conforming with one of the barometric systems, and the other with the system on the opposite side of the place of observation. The sequence of wind observations at the surface would support such a view for these occasions. The bounding plane between the two currents would be a region where stratus clouds, due to mixing of moist air of different temperatures, would be liable to form. There may be some feature of the Darwen Moor which would locally facilitate such a process.

AT the suggestion of the Palestine Exploration Fund, an organising committee has been constituted by the British Academy with the object of founding a British School of Archæology at Jerusalem. The committee, in a memorandum just issued, points out that while American, French, and German schools of archæology existed in Jerusalem before the war, this country possessed no such institution. It is proposed to establish a school to be devoted, both by excavation and surveying, to the furtherance of Palestinian archæology in all its branches. In addition to Hebrew and Jewish sites and antiquities, the school would include within its scope the Canaanite, Græco-Roman, Byzantine, Arab, and Medieval periods. An essential part of the scheme is that the school should be not only an excavating body, but also a training school for archæologists. It is hoped that universities, colleges, other institutions, and private patrons will pro-

vide a number of annual scholarships of 100*l.* each. The organising committee invites contributions towards an endowment fund, which has been started with gifts of 1000*l.* each from Mr. Walter Morrison and Mr. Robert Mond. It is hoped that a minimum of 20,000*l.* will be raised. Mr. Robert Mond will act as treasurer of the fund, and contributions should be made payable to him, crossed "a/c British School of Archæology at Jerusalem." All communications should be addressed to the honorary secretary, Prof. I. Gollancz, British Academy, Burlington House, Piccadilly, W.

EARLY in 1914 Mr. J. Reid Moir began to make a detailed study of two ancient levels formerly occupied by man, now buried in a brickfield near Ipswich. He has just completed the work, which is the most exhaustive research of the kind hitherto undertaken in this country, and the results are published in the last part of the Journal of the Royal Anthropological Institute (vol. xlvii.). With the aid of several specialists, whose reports are included, Mr. Moir deals with the subject from every point of view. The flint implements are illustrated in many beautiful drawings by Mr. E. T. Lingwood, those of the lower level being clearly late Mousterian, while those of the upper level are Aurignacian. Two specimens found in the hill-wash overlying the upper level are Solutrean, and an arrowhead from the surface soil is Neolithic. These implements were examined by the late Prof. V. Commont, who noted that they represented the same succession of types as he had discovered in the loams and alluvium of Northern France and Belgium. Some fragments of human bones found on the lower level are considered by Prof. Keith to be essentially identical with those of modern man. Some pieces of pottery from the same level are also interesting.

THIRTY-FIVE years ago a committee of the British Association compiled a table to represent the average heights and weights of British children at each year of growth. Experience has shown that the standards laid down by the committee are not satisfactory. In recent numbers of *School Hygiene* (December, 1917, April, 1918) Major James Kerr seeks to lay down what may be described as an ideal British standard. He assumes that the average Briton, if reared under healthy conditions, should reach the height of 1·770 m. (5 ft. 10 in.), some two inches above our present average. "By selection of the children to be measured, excluding the deformed and diseased, the backward mentally, and starved, ill-clothed, and city-dwarfed children, it should be possible to lay down standards for height considerably above the measurements at present considered satisfactory." Indeed, the standards laid down by Major Kerr are considerably above the measurements yielded by the best samples of British children. We believe that such an ideal standard will not prove satisfactory, because the admission or rejection of children considered healthy will depend on the individual judgment of the medical officer concerned. Nevertheless, Major Kerr's papers form a valuable contribution towards the solution of a difficult problem.

IN association with the article in our issue of May 16 on "The Co-ordination of Scientific Publication," it is of interest to note that at the Congress of Archæological Societies held in November last Mr. H. St. George Gray pointed out the desirability of more co-ordination in the exchange of archæological publications so as to secure for each society a full record of published work. The difficulty in completing sets of Proceedings arose generally from the fact that most societies had their scarce volumes due, amongst other causes, to the publication of important contributions of more than local interest, which led to an abnormal demand on the number of copies printed. As a result, odd volumes required to complete library sets had to be sought in second-hand book lists, as the cost of reprinting scarce issues was usually prohibitive. Special publications, volumes issued for members only, and loose-leaf publications were often omitted from exchanges, and in the absence of carefully compiled indices important contributions were often either overlooked or seriously delayed. Adequate index volumes are of especial value in archæological publications, and should be issued and exchanged by all societies concerned with the subject. An additional consideration arose from the fact that indices were often published as extra volumes, and were not included in exchanges. Although the value of exchanges between societies was regarded from the scientific rather than from the commercial point of view, any difficulties connected with special issues of this character should be capable of equitable adjustment by proportional payments.

LITTLE is yet known in regard to the reproductive organs of the Cetacea. A paper on this subject, which appears in the *Journal of Anatomy*, vol. iii., part 2, by Prof. Meek is therefore welcome. Prof. Meek deals with the modifications these organs present in relation to function rather than with their general disposition. Both sexes of the common porpoise (*Phocaena communis*) and the male organs of the white-beaked dolphin (*Lagenorhynchus albirostris*) are described at length, and some valuable notes on the male organs of other species of Delphinidæ and on the remarkable spermathecal recess of female Cetacea are also given.

THE March issue of the *American Museum Journal* (vol. xvii., No. 3) contains among several admirably illustrated articles one by Mr. D. B. Macmillan on "The Food Supply of the Smith Sound Eskimo." After surveying the abundant food supplies during the polar summer, Mr. Macmillan shows how the Eskimo, who is perforce entirely carnivorous, consumes about 1000 lb. of meat a year, about half of which is eaten raw and frozen. A high proportion of this generous diet is consumed during summer and autumn. Winter is often a period of want. Mr. Macmillan points out that probably already the war has affected the well-being of these far northern people. For many years they had depended on Danish trading ships not only for tobacco, matches, thread, needles, etc., but, more important, for firearms, knives, steel traps, and other implements of the chase. The non-arrival of the trading ship in 1917 forced the Eskimo largely to fall back on the hunting methods of a century ago—to bone arrows, ivory harpoon-shafts, flint knives, and so forth. Another year of these conditions, Mr. Macmillan believes, will result in so great a falling off in food supplies that the tribe will dwindle to a pitiful few.

M. LEROY described before the Société des Experts Chimistes de France recently a new process of examining eggs by photography. The opacity of the shell is got over by using intense illumination, a luminous objective, extra-sensitive plates, and other suitable devices. M. Leroy uses a graduated transparent scale, which is reproduced photographically at the same time as the egg. The method described has the advantage over the "shadow" method that it reproduces the internal condition of the egg. The eggs are tested in the way that steel rails, shells, etc., are—*i.e.* by selecting a certain percentage for test from each batch.

DR. L. DE LAUNAY, in the issue of *La Nature* for May 18, describes the efforts of a French company to cultivate the eucalyptus and pine on a large scale in the Peñarroya district of Spain (on the borders of Córdoba and Ciudad Real) for the production of paper-pulp. At first the geological conditions of this region were not considered favourable for intensive afforestation, but experiment showed that the two woods mentioned would yield satisfactory results under proper treatment. The results are justifying expectations, and it is hoped that the once barren region will in a few years repay the time and money spent in developing it. The wood will be used for pulping, pit-props (there are mines near), and for the distillation of acetic acid, etc.

FROM a copy we have received of Prof. Righi's paper on the ionisation produced by X-rays in a magnetic field, which appeared recently in the *Annales de Physique*, it is evident that the presence of a magnetic field has an influence on the process of ionisation of gas molecules not taken into account in previous descriptions of the process. If two horizontal plates are maintained at a difference of potential in a rarefied gas through which X-rays are passing, and the electric current between the plates is measured, we get the well-known relation between the current and the applied potential. If a horizontal magnetic field is superposed on the electric field between the plates, we should expect the deflection of the electrons produced by the field to diminish the current between the plates. This Righi finds to be the case for fields of 1000 gauss, but for fields of 300 or 400 gauss he finds the current is increased slightly by the presence of the field. He ascribes this effect to the electron placing itself so that its orbit is perpendicular to the field. The force of the field on it then being centrifugal, there is an increased tendency for ionisation to occur in the gas.

THE *British Journal of Photography* in its issue of May 5 directs attention to the numerous openings for improvements in optical apparatus as at present constructed, and advises manufacturers to employ experts to examine and improve their designs. As examples, it suggests the provision of two shallow saw-cuts at opposite ends of a diameter of each bezel ring used in a lens mount, so that by placing the edge of a steel rule in the cuts the ring can be easily removed. For lantern condensers the fine threaded screw method of mounting should be given up and replaced by the bayonet catch, or, better, by a stiff spring ring inside the mount holding the front lens against a loosely fitting separating ring, which in turn holds the back lens against a flange on the inside of the mount at the lantern end. Holes should be provided in the mount to allow any condensed moisture to get away. The condenser should be mounted in a cradle, which will allow of its insertion and removal when the lantern is in use without its being necessary to remove the lamp and withdraw the condenser through the body of the lantern, as is so often the case.

PROF. E. W. MARCHANT read an interesting paper on "Some Transient Phenomena in Electrical Supply Systems" to the Institution of Electrical Engineers on May 24. The experiments were made with the help of an oscillograph at the electrical station and substations of the Liverpool Corporation. Prof. Marchant investigated the "current-rushes" on switching transformers into the circuit. The results obtained bear out the conclusions which Prof. Fleming arrived at in the experiments he carried out twenty-five years ago at the Deptford power-station of the London Electric Supply Corporation, which was the first high-tension supply station in the world. Prof. Fleming's apparatus was, naturally, more primitive, but with the help of vacuum tubes and improvised electrical stethoscopes he detected all the main phenomena. We were specially interested in Prof. Marchant's oscillograms, showing the rush of current which ensues when an induction motor is switched into a circuit, as they prove that, although the initial rush of current may be the same whether the machines be carefully synchronised or not at the moment of switching in, yet the current diminishes to its steady value much more rapidly in the former case. The latter part of the paper on the current-surges which occur when putting alternators in parallel, and the transient currents which ensue on switching on and off high-tension cables, although containing little that is novel, gives excellent illustrations of the substantial accuracy of the ordinary differential equations used by engineers.

OUR ASTRONOMICAL COLUMN.

EARLY HISTORY OF THE SOLAR SYSTEM.—An important contribution to the mathematical investigation of the evolution of the solar system has been made by Dr. Harold Jeffreys in a communication to the Royal Astronomical Society (Monthly Notices, vol. lxxviii., p. 424). It is first shown to be improbable that the planets were formed by the gradual condensation of a gaseous mass, and it would seem that they were strongly condensed from the beginning, and were formed catastrophically. The tidal theory is therefore adopted, according to which a star of mass several times greater than that of the sun approached it so closely that the tidal action resulted in the extrusion of one or two streams of matter having a considerable velocity. These streams would break up almost at once into a series of fluid masses, and the gaseous matter set free in the initial disruption would form a resisting medium, the effect of which would be to reduce the eccentricities of the original orbits. From the rate of change of eccentricity it is provisionally estimated that the age of the solar system is 3×10^9 years, which is in general agreement with the age derived by radio-active methods. Among other results of interest it is shown that all the bodies having diameters less than 1000 km., if assumed to be composed of silica, must have been liquid or solid from the beginning, as smaller masses could not have been held together by their own gravitation when in the gaseous state. Dr. Jeffreys considers that the asteroids were probably formed from a primitive planet which approached Jupiter so closely as to be broken up by tidal action.

STELLAR INVESTIGATIONS AT MOUNT WILSON.—In the *Journal des Observateurs*, vol. ii., No. 6, Mr. W. S. Adams gives a brief account of the more general stellar investigations which have recently been carried on at Mount Wilson Observatory. Following an explanation of the spectroscopic method of determining stellar parallaxes, it is stated that the method has now been applied to more than a thousand stars, and that the precision of the results appears to be of the same order as that of parallaxes measured directly. In regard to stellar motions, space velocity appears to be mainly a function of absolute magnitude, the fainter stars moving more rapidly than the brighter, probably to some extent on account of difference in mass, the less massive stars having the greater velocities. A recomputation of the constants of the solar motion gives the position of the sun's apex as R.A. 270·9°, decl. +29·2°, and velocity 21·48 km. The investigations of stream motion furnish considerable support to the view that the stars show a motion of revolution around the centre of the galaxy, and that

stream motion is mainly a local effect of this revolution. Studies of star clusters and of the comparative spectra of near and distant stars have indicated that the amount of absorption or scattering of light in space must be extremely small. The 60-in. reflector has been used to establish magnitude scales over a wide range, the faintest stars included being of photographic magnitude 20·1.

SPECTRA OF CHROMOSPHERE AND CORONA.—The results of measurements of a plate obtained at Vavau, Tonga Islands, during the total eclipse of the sun of April 28, 1911, have recently been given by the Rev. Father A. L. Cortie, S.J. (Monthly Notices, R.A.S., vol. lxxviii., p. 441). The photograph was taken with a prismatic camera under somewhat unfavourable conditions, but it extends far into the red, and twenty-five chromospheric lines not previously recorded have been found between λ 6600 and λ 7640. The majority of these are probably due to iron, but there is a fairly strong line at λ 6941, which remains unidentified. There are indications of a new coronal radiation about λ 7150, which is possibly related to the previously known line at λ 5535·8, in agreement with the theoretical investigations of Prof. Nicholson.

THE METRIC SYSTEM AND DECIMAL COINAGE.

NOTWITHSTANDING the growing demand in this country for our adoption of the metric system of weights and measures and a decimal system of coinage, the Committee on Commercial and Industrial Policy after the War has reported against the early introduction of both these overdue reforms. It is proposed in the following commentary upon the Committee's recently issued report (Cd. 9035, chaps. x. and xi.) to show that the arguments upon which these decisions are based are open to considerable criticism. For ease in reference these comments generally follow the sequence of the report.

The Metric System.

The Result of the Permissive Act of 1897.—In its historical review of the previous efforts to establish the metric system in this country, the Committee states that, although the use of the metric system has been permissive for the last twenty years, the number of metric weights and measures presented annually for verification and stamping is now only about 1 per cent. of the number of Imperial weights and measures similarly presented. The Committee has apparently failed to realise that the Act of 1897 alone could not possibly extend our use of the metric system, because, for example, it is obviously impracticable for tradespeople to have two different sets of weights—in different systems—in concurrent use on their shop-counters. It is also unreasonable to expect British manufacturers to employ the metric system in their workshops so long as our railways are permitted to refuse consignments of their products unless the Imperial equivalents of the weights and dimensions are also stated.

Further evidence of the futility of this Act as a measure for encouraging the use of the metric system in this country is unconsciously supplied by the Committee itself in its statement that even our present limited use "appears to arise mainly in connection with the recent legislation of metric carat weights and the adoption in the British Pharmacopœia of metric weights and measures for the prescription of doses." The 1897 Act has thus proved a dead letter, and further legislation is already long overdue.

As in the case of the daylight-saving scheme, the community as a whole cannot enjoy the benefits of the metric system until its use is established by law.

The Difficulty of Spare Parts and Renewals of Machinery.—The report states that, in order to enable the British machinery-maker to supply spare parts and renewals, it would be necessary for him to continue the Imperial system in use, side by side with the metric system, for possibly a generation after our official abandonment of the Imperial system, and that he would accordingly be required to work in two systems for that period.

This objection evidently arises from an unwarrantable assumption that our adoption of the metric system would necessarily involve altered dimensions of machine parts. Such is not the case, because obviously any dimensions now expressed in inches and parts thereof can be readily expressed in millimetres and parts thereof. It should be remembered that a tolerance of one-hundredth part of a millimetre demands much more accurate work than is usually obtainable in our machine-shops; so that those opponents of metric measures who claim that metric equivalents of Imperial dimensions can be shown only by employing six figures or so after the decimal point are obviously drawing on their imagination and appealing to the credulity of those whose support they seek.

British manufacturing engineers have for years worked in mils (0·001 in.), and the worst the metric system could demand of them, viz. 0·01 mm., would thus represent a saving of one figure in written dimensions. In practice, for small dimensions, two or more figures would generally be saved, because the dimension 0·1 mm. (roughly four mils, or 0·004 in.) would be quite fine enough for most of their work. Equivalents expressed even so approximately as the nearest whole millimetre—thus dispensing entirely with the decimal point—could not differ from the original Imperial dimension by more than one-fiftieth part of an inch.

Furthermore, the passage of an Act requiring all sales to be made in terms of the metric system would not affect the liberty of any person to continue his use of the existing weights and measures for manufacturing purposes until such time as he himself chose to abandon them. All existing patterns could thus be employed for the full term of their useful lives, and when in the normal course they became worn out or obsolete in design they could be economically replaced by new ones based on the metric system.

Manufacturers engaging in new industries should, at the outset, base their designs on the metric system, and it is gratifying to note that this has been done, for example, in the case of the British magneto industry, which has been so successfully established in this country since the outbreak of the war.

The Value of a Universal Language of Quantity.—Regarding the point raised by the Committee that if we now adopted the metric system we should be required to work in two systems for a generation, it may be remarked that, even were this true, it would be much less appalling than our alternative prospect of employing two systems for all time. The fact remains that, whether we like it or not, we already find ourselves obliged to use the metric system to an ever-increasing extent in scientific work, in manufacture, and in export trade; and the retention of our own Imperial system thus handicaps us by compelling us to employ two systems where one would suffice.

When we realise that our national existence depends upon our ability to sell British manufactured goods to all nations, *i.e.* to develop a world-wide trade, it is obvious that Great Britain—more than any other country—would benefit from the establishment of a universal system of weights and measures.

The use of the metric system is already obligatory in thirty-four countries, representing a population of 437 millions, and optional in a further eleven countries having a population of more than 727 millions. By ourselves adopting it we should practically ensure its establishment as the universal language of quantity, but, on the other hand, it is equally clear that the Imperial system could never become the universal system because of its inherent defects.

The Influence upon our Export Trade.—In opposing the proposal that legislation should be introduced whereby all *sales* would be required to be expressed in metric terms, the Committee states that "the continuance of manufacture on the existing system while the sale of the product had to be made on the metric system would be confusing and inconvenient."

This admission illustrates the indifference of the Committee to the "confusion and inconvenience" which it evidently considers British exporters should continue to suffer, because it is precisely under these conditions that we are attempting to expand our overseas trade. After the war it will be just as necessary for Great Britain to organise and develop her export trade—in order to reduce the burden of taxation and restore her financial stability—as it has been for her to organise the manufacture of munitions during the war, and yet the Committee cannot agree to assist our exporters by removing this unnecessary "confusion and inconvenience."

Are we for ever to remain deaf to the advice of our overseas commercial representatives—both Government and private—who for years past have urged us to adopt the metric system? The opinions of these "men on the spot" are apparently quite ignored, as no reference is made to them in the report.

This brings me to the Committee's remarkable statement that, as more than half the volume of our pre-war export trade was with non-metric countries, we should stand to lose more than we could gain if we adopted the metric system. Realising apparently how unsubstantial this argument is, the Committee proceeds to qualify it by saying:—"The position would no doubt be materially altered *if*" the Colonies and other outstanding countries "would simultaneously with us adopt the metric system." It is curious that, in regard to the Colonies, any doubt of their readiness to follow our lead should be entertained, especially as in the same report the Committee states:—"At the Colonial Conference of 1902 a resolution in favour of the introduction of the metric system throughout the British Empire was carried." This desire was confirmed by the Dominions Royal Commission Report of 1917, which stated, in regard to the metric system:—"There is clearly in the Dominions a considerable body of opinion in favour of the change. So far, however, all efforts to induce the community in the Mother Country to agree to a change have proved unavailing."

According to statistics quoted by the Committee in another part of the report (chap. ii.), rather more than one-third of the annual value of the exports of the produce and manufactures of the United Kingdom went to British Possessions during the fourteen years ending 1913, and the item coal represented "fully three-quarters of the total weight of our exports of all kinds."

Obviously, coal could be exported just as readily in metric tons as in Imperial tons, so that if the Committee had boldly stated that Great Britain's adoption of the metric system would certainly be followed promptly by similar action on the part of the Colonies and British Possessions, and probably by America at no very distant date, they could have presented a strong case in favour of the metric system instead of a weak case against it.

In concluding that the United States would be opposed to the metric system, the Committee has apparently failed to appreciate that it was anti-metric only so long as its products were principally destined for home consumption or for export to the British Empire. But note what is happening now that the United States aspires to become an exporting nation in the widest sense. In the last few years the American demand for the metric system has grown enormously, and in his report, dated January, 1916, to the International High Commission relative to the use of the metric system in export trade, Dr. S. W. Stratton (Director of the Bureau of Standards at Washington) said:—"Any manufacturer who, through ignorance, fear of confusion, or lack of enterprise, is unwilling to attempt to meet the requirements of foreign trade should confine his attention to our domestic trade. He should not, however, be permitted to retard the development of foreign trade by his inertia or indifference to the metric system, which is now the legal system in thirty-four of the countries whose trade we seek. Still less should his opposition or his opinion have consideration in comparison with the judgment of those who seek earnestly and by all possible means the extension of trade with metric countries."

Note also the significance of the official announcement published in January, 1918, to the effect that the United States War Department had adopted the metric system for the artillery, machine-guns, and maps required by their armies in the present war. Whether Great Britain or the United States takes the lead in the complete adoption of the metric system, it is reasonably certain that the other would quickly follow, and, in view of our greater dependence on overseas trade, it is clear that we ought to move first.

The Effect upon our Competition with Germany.—The statement that our adoption of the metric system would place us at a disadvantage with Germany should be contrasted with the attitude of the German nation, which, in the early 'seventies, adopted what was known as the French system, notwithstanding the anti-French sentiments then existing on account of the Franco-Prussian War. Since that time twenty-four other countries have likewise adopted what is now truly described as the *international* metric system, and we accordingly remain a non-metric country to our own serious disadvantage. The war has demonstrated the need for greater intimacy of contact between the man of science in his laboratory and the industrialist in his workshop. In Germany the metric system is common to both these partners in progress, but in this country, while the metric system is the language of science, it is a comparatively unknown tongue in our workshops. Is it to our advantage that this estrangement should be perpetuated? If we adopted the metric system at once we should surmount the temporary difficulty of accustoming ourselves to the metric notation long before Germany emerged from under the cloud of the world's disapproval consequent upon her infamous acts in the present war. We cannot, however, rely upon this sentiment lasting more than a few years, so we should act promptly. All our industries will require overhauling when we abandon the manufacture of war munitions in favour of peace products, and it is wrong to assume that we shall simply revert to pre-war standards. New methods, new designs, new ideas will be the order of the day, and the time will be particularly opportune for starting afresh on the metric basis.

The Opposition of the Textile Trade.—Evidence of the antagonism of the textile trade appears in several parts of the report. This attitude suggests the thought that even assuming the textile industry feels so sure of its grip on the world's markets that it can afford

to dispense with the benefits of the metric system and to ignore the convenience of its overseas consumers, that is no adequate reason in itself why all the other industries of the nation should be deprived of the support they would derive from Great Britain's adoption of the metric system. It may be recalled that the watch industry of Switzerland similarly held out against the Swiss adoption of the metric system, and that it was accommodated by being specially exempt from the compulsory provisions of the Metric System Act. But what was the sequel? A very few years' experience proved to the Swiss watchmakers that they had denied themselves advantages which their fellow-countrymen enjoyed, and they then accordingly voluntarily fell into line. It is to be hoped the British textile industry will note and profit by this example.

In the meantime, it is well also to bear in mind the facts recorded by the Committee in chap. ii. that "of the yarns exported in 1913, about one-third was taken by Germany" (already a metric country), and that "rather more than half of the total exports of piece-goods went to British Possessions," which, as mentioned above, only await the lead of the Mother Country to justify their adoption of the metric system.

The Educational Aspect.—The Committee's attempt to discount the advantages of the metric system in educational matters is very weak, and may be usefully contrasted with the authoritative statements published in the recently issued "Report of the Committee Appointed by the Prime Minister to Inquire into the Position of Natural Science in the Educational System of Great Britain" (Cd. 9011). One of this Committee's summarised conclusions reads:—"That the present chaos of English weights and measures causes waste of time and confusion of thought, and that there are strong educational reasons for the adoption of the metric system."

The "Improvement" of the Imperial System.—Realising that although it cannot recommend the metric system it also cannot establish the superiority of our existing system, the Committee adopts the expedient of advocating the so-called "improvement" of the Imperial system. To that end the members "emphasise the advantages, already widely recognised, of using decimal subdivisions of our basic units, such as the inch and the pound weight." This leaning to decimalisation is especially noteworthy in view of the contradictory opinion expressed elsewhere in the report that "for practical purposes binary divisions are better than decimal."

In this connection it is instructive to recall the recommendations of the Select Committee of the House of Commons which so long ago as 1862 reported that "it would involve as much difficulty to create a special decimal system of our own as simply to adopt the metric system in common with other nations, and if we did so create a national system we would in all likelihood have to change it again in a few years as the commerce and intercourse between nations increased into an international one." That was fifty-six years ago. Further comment is superfluous. If instead of decimalising English units, we could agree forthwith to express all weights and dimensions in terms of single units (*e.g.* pounds, yards, and gallons), abolishing all the chaotic multiples of 12, 3, 5½, 40, 8, etc., the way would be paved for our early adoption of the metric system.

Decimal Coinage.

The report reviews the various proposals which have been made from time to time, and concludes that our ultimate choice must rest between (*a*) the retention of the £ sterling as the monetary unit and its division into 1000 parts, or (*b*) the creation of a new monetary unit equal to 100 halfpence—viz. a gold dollar of 4*s.* 2*d.*

After recording its opinion as being strongly in favour of the first of these alternatives, the Committee enlarges upon the difficulties incidental to the decimalisation of the £ sterling, and concludes, by a majority (not unanimously), that the change would be inexpedient at the present time or in the immediate future.

The above-mentioned difficulties fall chiefly under two heads, viz.:—(1) The necessary alteration of the value of the penny. (2) The use of three figures after the decimal point.

Of the former it may be said at once that it is high time the penny coinage was changed, because of its failure to meet fluctuations in currency values and gradual changes in the prices of small articles and services.

By way of illustrating the failure of the penny to meet present-day needs, it will have been noted that while the cost of many daily necessaries may have been increased by (say) 20 per cent., it has been necessary to raise the price of halfpenny goods and services by 100 per cent. to one penny, and of penny ones by 50 per cent. to 1½*d.*, because of our lack of coins to represent intermediate values. The case of the penny stamp is a recent example. This unsuitably steep grading of the present coinage has proved a source of hardship, especially to the poorer classes, who are obliged to purchase food and other daily requirements in "pennyworths."

The provision in the new Bill of an enlarged range of low-value coins should greatly facilitate the change from pence to mils. As, for example, neither the 4-mil nor the 5-mil coin would be exactly equal to the present penny, it is thought better to include both coins than arbitrarily to say that the new penny shall be either 4 per cent. less or 20 per cent. more than the present penny. In course of time any coins which experience had shown to be superfluous could be withdrawn from circulation.

The equivalent in mils of any sum now stated in pence would be ascertained by adding one-twenty-fourth part to the number of farthings contained therein, from which it will be seen that each complete sixpence would have its exact equivalent in twenty-five mils. On this basis all new coins could be issued to the public in exact exchange for existing coins, thus avoiding loss to either the individual or the State.

In order to meet the second difficulty, which is more apparent than real, of employing three figures after the decimal point, it is suggested that the present three-column method of cash entry might be retained. The existing cash columns, rechristened £ *f.* *m.* instead of £ *s.* *d.*, would conveniently separate the pounds from the florins and the florins from the mils, and *no decimal point would be required.* Instead of learning "12 pence in a shilling and 20 shillings in a pound," school children would be taught "100 mils in a florin and 10 florins in a pound." Under this arrangement prices lower than a £ would be quoted in florins and mils just as we now employ shillings and pence.

In its criticism of a draft Bill (submitted by the Institute of Bankers) the Committee makes the erroneous statement that this has been adopted also by the Association of Chambers of Commerce and the Decimal Association. What really happened was this: After the bankers' draft Bill had been submitted to the Committee, conferences took place between the three above-mentioned organisations, and a new Bill (based upon the bankers' draft but containing important modifications and improvements)

was mutually adopted by the unanimous agreement of all the parties.

Attempts were made to lay these new proposals before Lord Balfour's Committee, but a reply was received to the effect that the Committee had by that time ceased to take evidence, and nothing could be done. This is particularly to be regretted, because the improved Bill meets many of the difficulties mentioned in the Committee's report.

The new Bill has just been before the House of Lords, and consideration of it has been postponed on the understanding that the Government will institute an inquiry into the whole question. The Bill received widespread and influential backing, having been introduced by the Association of Chambers of Commerce of the United Kingdom (representing more than 130 Chambers throughout the country), and supported by the Decimal Association and many organisations representative, among others, of:—*Finance,* the Institute of Bankers; *Commerce,* Chambers of Commerce; *Industry,* Federation of British Industries; *Science,* British Science Guild; *Transport,* Municipal Tramways Association; and many professions and trades. This unanimity of organised opinion augurs well for the eventual adoption of a reform which, as hinted at by the Committee, has possibly suffered more hitherto from the diversity of advice tendered by its advocates than from any real opposition either in or out of Parliament.

HARRY ALLCOCK.

PROGRESS OF THE EDUCATION BILL.

DESPITE the pressure of other urgent measures and the consequent limitations as to time, and in spite also of the persistent opposition of certain Members, good progress is being made with the Education Bill in the House of Commons. Already clause 10, the crucial clause of the measure, which is to secure the continued education of young persons from fourteen to eighteen years of age who have entered into employment, has been reached. It is to be hoped that the endeavour of Mr. Fisher to preserve the contact of adolescent youth with the humaner side of life during these formative years, whilst giving effect to all reasonable opportunities for enhancing both knowledge and aptitude in the chosen vocation, may receive complete support and be assured of legal enactment.

It is in this connection satisfactory to find that the great evil of half-time, which has mainly characterised the textile industrial areas of the country, has found little support in the House, and clause 8, section 1, abolishing all exemptions up to the completion of the fourteenth year of age (to come into operation on the close of the war), has been passed without a division. We thus secure that the child in the elementary school will now have at least a complete preliminary course of education and training from the beginning of his sixth to the completion of his fourteenth year, and the nation comes into line with the more advanced industrial and commercial nations of the Continent who are its greatest rivals.

Moreover, liberty to raise the school age until the completion of the fifteenth year of age, with or without exemptions, at the option of the local education authority has secured the assent of the Committee by a very large majority, and it is further provided that adequate provision shall be made in order to secure that children and young persons shall not be debarred from receiving the benefits of any form of education by which they are capable of profiting through inability to pay fees. In view of the necessity of encouraging the development of higher education in county areas, it is satisfactory to find that there was unanimous assent to the abolition of the limit of expenditure from the rate by county council committees.

Provision is made for the due inspection of private schools with a view to the elimination of unsatisfactory establishments by bringing them under the direct supervision of the local authorities and of the Board of Education. A step has also been taken at the option of the local education authority to raise the compulsory age of entrance to the elementary school from five to six years, provided that adequate provision is made in the area for the establishment of duly equipped nursery schools. It is a pleasant thing to note that in the establishment by scheme of joint committees teachers are expressly named as eligible for co-optation. The efforts of the friends of this important measure should now be firmly concentrated upon the provisions of clause 10, so as to secure that the proposals of Mr. Fisher, who has so far piloted the Bill with such admirable tact, shall be given legislative effect. Whatever be the merits of the Hibbert amendment, and they are by no means absent, they are not comparable with the advantages to be gained by the intimate association of young persons with the beneficial influence of the schools up to the conclusion of their eighteenth year.

ORGANISATION OF GLASS INDUSTRIES.

THE Society of Glass Technology held an important meeting at the Institute of Chemistry on May 15, when the president, Mr. Frank Wood, in opening a discussion on "The Glass Industry after the War," advocated the formation of trade councils for the organisation of the various sections. He proposed that a federation should be formed, controlled by a council consisting of sectional representatives, both manufacturers and men, together with representatives of science, the Government, and finance. The matter should be taken in hand immediately, and every effort made to secure workmen and machinery to enable the country to supply all its requirements, instead of about 20 per cent. in pre-war days. To do this, Government assistance is necessary. Without protection in some sections and prohibition in others, there would be a deluge of foreign glass just when their furnaces and shops ought to be undergoing repair and when time would be required for the training of workers. They should be ready for the future, and the Optical Munitions and Glassware Supply Department of the Ministry of Munitions, to which they were so much indebted, should continue in being to help them. Mr. Connolly voiced the need for a dump-proof Empire in order that a fair chance might be given to home production. Sir Frank Heath dealt with the necessity for bringing science to bear on the matter, assuring the meeting of the desire of the Government to assist research through industrial organisations. The conditions under which grants are made are not onerous, and the researches are conducted free from meticulous interference from headquarters. Mr. Douglas Baird referred to the production of chemical ware, which will not be able to stand on its feet for some time without the aid of "foster-parents." Sir Herbert Jackson spoke hopefully of the general outlook. National prestige must supply the stimulus for pulling together after the war. Their representatives should be brought into collaboration with Government representatives to deal with the problems before them. Mr. Biram, of the Ministry of Munitions, acknowledged the great help of the manufacturers in the production of war material; the future would call for all their energy and enterprise. Dr. Rosenhain appealed for the fullest utilisation of scientific results and the interchange of knowledge and experience. Mr. S. N. Jenkinson said that the industry must make itself efficient if it is to be supported by the Government. Many other members joined in the discussion, and it

was agreed that a resolution on the policy of the society should be circularised among the members for consideration before the next meeting, which is to be held in Sheffield on June 19. Before the meeting the members enjoyed a visit to Messrs. Ediswan, Ltd., at Ponders End.

THE ROYAL OBSERVATORY, GREENWICH.

THE report of the Astronomer Royal to the Board of Visitors of the Royal Observatory, Greenwich, was read at the annual visitation of the Observatory on Saturday, June 1. The subjoined extracts are from the report.

Greenwich Catalogue.

Advantage is being taken of the delay in the printing of the Greenwich catalogue of 12,000 stars for 1910 to insert the type of spectrum as well as the magnitude of the star on the Harvard scale. This has been made possible by the kindness of Prof. Pickering, who is supplying, partly in manuscript and partly in early proofs, the results of Miss Cannon's survey at Harvard College. Discussions of some points connected with the proper motions of the stars in this catalogue have been communicated to the Royal Astronomical Society, and others are in progress.

Heliographic Observations.

In the year ended May 10, 1918, photographs of the sun were obtained on 209 days. The transmission to England of the solar photographs taken at the Royal Observatory, Cape of Good Hope, has been suspended for the present, the last originals received being those for February, 1917, and the last duplicates those for the month previous. Similarly, no application has been yet made for photographs taken at the Indian observatories of Kodaikanal and Dehra Dûn to fill up gaps in the combined Greenwich-Cape record. The days in 1917 left without representation in the combined record are only nine in number, and for eight of these days photographs taken at Kodaikanal are available; the only date in 1917 still without a photograph being March 12.

H.M. Astronomer at the Cape has reported that the sun was successfully photographed there on 333 days in the year 1917, and on every day in January, 1918. The director of the Kodaikanal Observatory has reported that the regular series of photographs of the sun was recommenced there on April 1, 1917, and that plates were taken on 248 days out of the 275 of the nine remaining months of the year.

During the whole of the period covered by this report the spot-activity has been considerable, but it reached a remarkable development during August, 1917, the mean daily spotted area during the second week of that month being the highest as yet registered in the Greenwich photographic record. No disturbance comparable with this has occurred since, but considerable secondary maxima, with total spotted areas of more than 1000 millionths of the sun's visible hemisphere, were observed in September and December, 1917, and in February and March, 1918.

Magnetic Observations.

The mean values of the magnetic elements for 1917 and three previous years are as follows:—

	Dec. W.	Hor. force	Vert. force	Dip
	° ′			° ′
1914 ...	15 6·3	0·18518	0·43317	66 51·2
1915 ...	14 56·5	0·18508	0·43315	51·8
1916 ...	46·9	0·18494	0·43313	52·7
1917 ...	37·0	0·18477	0·43305	53·6

The annual diminution of declination increased considerably about 1910, its average value from 1900 to 1910 being 4·9′. The horizontal force, which had been increasing since measurements were begun at Greenwich in 1846, reached a maximum about 1910, and is now diminishing. The dip, which has been diminishing since measurements were begun in 1843, reached a minimum about 1913, and is now increasing.

There were no days of great magnetic disturbance in 1917, but four were classified as of lesser disturbance. Traces of the photographic curves for these days will be published in the annual volume.

Meteorological Observations.

The following details of the weather refer to the year ended April 30, 1918. The mean temperature was 50·0°, or 0·4° above the average of the seventy-five years, 1841–1915. The highest temperature in the shade was 93·2° on June 17, and the temperature exceeded 80° on fifteen days. The lowest temperature was 17·2° on December 19, and on fifty-three days fell as low as 32·0°.

The mean daily horizontal movement of the air was 298 miles, which is fourteen miles above the average of the previous fifty years. The greatest daily movement, 767 miles, was recorded on November 24, and the least, forty-seven miles, on December 20. The greatest recorded pressure on the square foot was 18·8 lb., on October 25; the greatest velocity in one hour, forty-six miles, was registered on the same day.

The duration of bright sunshine registered by the Campbell-Stokes instrument was 1668 hours out of a possible 4456 hours, or 36·1 per cent. January provided more and April less than any corresponding month since the present instrument was set up in 1897.

The rainfall was 28·06 in., or 3·82 in. above the average for the period 1841–1915. The number of rainy days (0·005 in. or over) was 156. March, with 0·97 in., was the driest, and August, with 4·56 in., the wettest month.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

BY the will of Dr. E. A. Letts, professor of chemistry in Queen's University, Belfast, who died in February last, his collection of minerals is bequeathed to Queen's University, and, on the death of his wife, 2100*l.* for the endowment of a scholarship in the University.

MR. JOHN OWENS, of Chester, has been authorised by certain friends to offer the University of Wales on their behalf 10,000*l.* war stock towards the establishment of a music directorship on the lines indicated in the report of the Royal Commission on University Education in Wales.

THE Education Bill and eugenics is the subject of an article by Mr. Wm. C. Marshall in the *Eugenics Review* for April (vol. x., No. 1). Mr. Marshall believes that the Bill bids fair, if loyally carried out, to satisfy the requirements of the intelligent artisan, and to assure him that he can in the future count on obtaining for any of his children, inheriting his qualities and reared under his care and supervision, an education which will assure their position in the industrial world. On these grounds the conclusion is that the Bill should be cordially welcomed by eugenists.

INTERESTING and instructive statistics concerning the growth of secondary education in England and Wales are contained in the Report of the Board of Education for the year 1916–17 (Cd. 9045). The total number of secondary schools in England regarded by the

Board of Education as eligible for grant during 1916–17 was 931, and in them there were 198,759 pupils, of whom 103,819 were boys, as compared with 189,487 pupils, of whom 99,205 were boys in the same number of schools during 1915–16. In addition to the 931 schools on the grant list, the Board recognised 125 other schools as efficient, and in these schools, during 1914–15, 25,033 pupils were being educated. Though the numbers for 1916–17 are not available, the report says it is probable that the number of pupils in these efficient schools increased, on the whole, in about the same proportion as in the schools on the grant list. The Board of Education has found that the withdrawal from the schools of the younger and more vigorous masters, and their replacement by others of lower physique, of more advanced years, and often of inferior qualification, is an educational loss for which there can be no effective compensation. The effect of increased entry and enforced stoppage of building has been to cause serious overcrowding, which, unfortunately, must for the present be regarded as inevitable.

IN his presidential address to the Society of British Gas Industries, Sir Robert Hadfield devoted one section to a consideration of the world's facilities for higher education. According to his investigations, there are about 280 universities in the world, with some 500 "special colleges" and 100 technical schools, staffed by about 53,000 trained teachers and investigators. Excluding India, the white population of the British Empire is about 65 millions, served by 48 universities, which gives one university for each 1¼ millions of population. In Great Britain and Ireland, with a population of some 45 millions, there are 18 universities, which works out at one university for each 2½ millions of population. In Canada, Australasia, and South Africa, where the population is distributed over very much larger areas, the proportion is naturally higher, and is about one university for each two-thirds of a million population. In France and Italy the proportion is just about the same as in Great Britain and Ireland. As regards Germany, if the technical high schools of university rank are grouped with the universities, the proportion is one per two millions of the inhabitants. In Austria-Hungary the proportion is about one per 4½ millions, and in Russia it is only one per 14 millions of population. The country which contains the largest number of universities, both absolutely and in proportion to population, is the United States of America, where one university exists for each million of inhabitants. Sir Robert Hadfield gives an interesting table showing the chief subjects dealt with in universities and technical schools, and the number of universities at which each subject is taught.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 16.—Sir J. J. Thomson, president, in the chair.—A. **Mallock**: Note on certain coloured interference bands and the colours of tempered steel. After alluding to the interference bands seen when two rows of posts, etc., or two gratings, are viewed one through the other, the paper deals with a particular case of such bands, namely, that when a plate of dispersive material, such as glass, is placed between the two gratings, or, which amounts to the same thing, when a single grating is placed on a thick mirror, and the interference takes place between the grating and its reflective image. The bands so formed are coloured. The composition of the colours in terms of primary red, green, and violet is given diagrammatically by means of Maxwell's chromatic triangle for nine examples. It is noticed that the sequence of colours in some of these agrees closely with those of tempered steel. It is shown that the colours of tempered steel are not "colours of thin plates," and it is suggested that they must be due to the formation of some material the molecular period of which is comparable with the period of light-waves, and not to a structure comparable with the wave-length.—J. C. M. **Garnett**: General factors in mental measurements. An inquiry into the mathematical argument for the existence of Prof. Spearman's general factor g, in all mental abilities of which measurements had been published during many years, led to an investigation into the consequences that must follow from the condition that the correlation between every pair of columns in a correlation table is ± 1. These consequences were found to be that there is one, and only one, factor common to all the qualities the correlations of which form the table; that there are no group factors common to two or more qualities but not to all; and that there may be any number of specific factors each belonging to one quality only. It was found that any quality which is distributed according to the normal law, and depends only on n independent factors (qualities), say $x_1 x_2 \ldots x_n$, which are distributed according to the normal law and have the same standard deviation, may be represented by

$$q = l_1 x_1 + l_2 x_2 + \ldots + l_n x_n$$

where

$$l_1^2 + l_2^2 + \ldots l_n^2 = 1.$$

The standard deviation of q, moreover, will be the same as of $x_1 x_2 \ldots x_n$. The existence is indicated of a third general factor c ("cleverness") independent both of Prof. Spearman's g ("general ability") and of Dr. Webb's w ("purpose"). How much would be known concerning the mental qualities of an individual whose g, w, and c had been measured is discussed in concluding the paper.—C. M. **Williams**: The absorption of X-rays in copper and aluminium. The paper deals with the relation between the mass absorption coefficients of X-rays in copper and aluminium and the respective wave-lengths over a range of 0·431–0·637 A.U. The relation between the two absorption coefficients are examined and the dependence of each of the latter on the wave-length. A notable feature is the occurrence of discontinuities in the curves representing the results; these may probably be connected with the J-series recently described by Barkla. With respect to the approximate relation between the mass absorption coefficient μ/ρ and the wave-length λ given by the equation $\mu/\rho = a\lambda^n + C$, where a, n, and C are constants, it appears that, while the relation is fairly well satisfied in the case of copper by giving n the value 5/2—a result in conformity with Owen's 5th-power absorption law—the results for aluminium show a value $n=3$.—Dr. T. R. **Merton**: The electrical resolution and broadening of helium lines. (1) The broadening of helium lines by condensed spark discharges is in close agreement with the electrical resolution of the lines. (2) The "isolated components" in the electrical resolution which have been recorded by Brunetti, and by Takamine and Yoshida, have been found in the broadened lines. (3) An explanation is offered of the relative degree of broadening of lines of the "arc" and "spark" type, on the supposition that the latter act as a kind of safety valve to the former when the intensity of excitation becomes very great. (4) It is suggested that the "isolated components" are not a

direct product of the electrical resolution, but are in reality an extension of the helium spectrum. Two of these lines may, perhaps, be represented as lines of combination series.

PARIS.

Academy of Sciences, May 21.—M. Léon Guignard in the chair.—P. **Termier**: Contribution to the knowledge of the tectonic of the Asturias.—C. **de la Vallée Poussin**: The best approximation of the functions of a real variable by expressions of given order.—E. **Ariès**: The saturated vapour pressures of tetratomic bodies. The method described in earlier papers is applied to the cases of ammonia, acetylene, and phosphorus trichloride. From the experimental data available a full comparison is only possible in the case of ammonia, and for this the agreement between the experimental and calculated values is very satisfactory.—J. **Pérès**: Some remarks on certain developments in series.—A. **Buhl**: The series of Taylorian polynominals and Weierstrass domains.—M. **Luizet**: Observations of the brightness of Nova Licorne.—A. **Véronnet**: The cooling and evolution of the sun.—C. **Matignon**: Ferro-silicons not attacked by acids. Analyses are given of six ferro-silicons and one ferro-boron and the loss on treatment with four acid solutions, two of nitric acid and two of mixtures of acetic and butyric acids, studied. The comparative losses under similar conditions are tabulated.—MM. **Masson** and **Faucon**: The absorption of ultra-violet radiations by the phenylmethanes. Details of measurements are given for benzene, toluene, diphenylmethane, and triphenylmethane.—Ed. **Chauvenet** and Mlle. L. **Nicole**: The basic nitrates of zirconyl.—D. **Berthelot** and R. **Trannoy**: The sugar content of *Sorghum saccharatum* at different stages of growth. The results of analyses of juice taken on eight dates between August 10 and November 30 show a maximum sugar content about October 5. It is shown that the richness in sugar can be calculated from the density of the juice.—L. **Cavel**: The antiseptic value of some essential oils. The experiments were carried out on diluted sewage, and the amounts of essential oil determined stopping all bacterial growth. Results are given for forty-five essences, phenol being used as a standard of comparison. Two-thirds of the essential oil examined proved to be stronger antiseptics than phenol, oil of thyme being the most powerful.—M. **Folley**: The aorta in exophthalmic goitre.

BOOKS RECEIVED.

The British Academy. Cosmic Law in Ancient Thought. By T. W. Rhys-Davids. Pp. 11. (London: H. Milford.) 1*s.* net.

Italian Mountain Geology. By C. S. DuRiche Preller. 2 parts. Part i., pp. 99; part ii., pp. 107 to 192. (London: Dulau and Co., Ltd.)

The Art of Health. By J. Long. Pp. xi+192. (London: Chapman and Hall, Ltd.) 5*s.* net.

An Introduction to the History of Science. By Prof. W. Libby. Pp. x+288. (London: G. G. Harrap and Co., Ltd.) 5*s.* net.

Acoustics for Musicians. By Prof. P. C. Buck. Pp. 152. (Oxford: Clarendon Press.) 7*s.* 6*d.* net.

DIARY OF SOCIETIES.

THURSDAY, JUNE 6.

ROYAL SOCIETY, at 4.30.—Brevity, Frequence of Rhythm and Amount of Reflex Nervous Discharge as Indicated by Reflex Contraction: N. B. Dreyer and Prof. C. S. Sherrington.

ROYAL INSTITUTION, at 3.—The Abode of Snow; Its Appearance, Inhabitants, and History: Sir F. Younghusband.

LINNEAN SOCIETY, at 4.30.—A Revision of Some Critical Species of Echium [Viper's Bugloss], as Exemplified in the Linnean and other Herbaria, with a Description of *Echium judaicum*, a New Species from Palestine: C. C. Lacaita.—Experiments with Cyclamen: Capt. A. W. Hill.—The Relationship between the Symbionts in a Lichen: R. Paulson and S. Hastings.—Abnormal Apple-blossoms and Fruit: W. C. Worsdell.

FRIDAY, JUNE 7.

ROYAL INSTITUTION, at 5.30.—The Romance of Petroleum: Sir B. Redwood.

SATURDAY, JUNE 8.

ROYAL INSTITUTION, at 3.—Problems in Bird-migration: Prof. C. J. Patten.

MONDAY, JUNE 10.

ARISTOTELIAN SOCIETY, at 8.—The Ontological Argument for the Existence of God: Prof. A. A. Cock.

ROYAL GEOGRAPHICAL SOCIETY, at 8.—The Backbone of Africa: Sir Alfred Sharpe.

SOCIETY OF ENGINEERS, at 5.30.—War on and under the Sea: Edwin Hall.

TUESDAY, JUNE 11.

ZOOLOGICAL SOCIETY, at 5.30.—On Two New Elasmobranch Fishes from the Upper Jurassic Lithographic Stone of Bavaria: Dr. A. Smith Woodward.—The Function of Pathology in Evolution: Morley Roberts.

WEDNESDAY, JUNE 12.

BRITISH ASSOCIATION GEOPHYSICAL COMMITTEE (Royal Astronomical Society), at 5.—*Discussion:* The Tides. Opener, Prof. H. Lamb, followed by Prof. Love, Mr. Proudman, and others.

THURSDAY, JUNE 13.

OPTICAL SOCIETY, at 7.—The Prevention of Filming in Enclosed Optical Instruments: H. S. Ryland.—A Chart for Finding the Number of Lenses in, and Size of, a Block: Horace Lee.—Charts for Assisting in the Selection of Suitable Glasses for Cemented Doublets: T. Smith.

FRIDAY, JUNE 14.

ROYAL ASTRONOMICAL SOCIETY, at 5.

PHYSICAL SOCIETY, at 5.—*Discussion:* The Teaching of Physics in Schools: Opener, Sir Oliver J. Lodge.

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