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Fuel and the Future.

THE World Power Conference to be held at Wembley on June 30-July 12, and the Empire Mining and Metallurgical Congress held on June 3-6, cover between them a very wide field in the production, distribution, and utilisation of power. If we ignore the fascinating but remote possibilities of the utilisation of atomic energy, the future of power production in Great Britain means the future of coal production and utilisation. The great increase in the cost of coal during the last decade has brought the question of its more efficient utilisation into prominence, and the present is an appropriate time to review the situation, in order to see what scope exists for economy.

Increased economy in the use of coal does not necessarily imply that less will be used, but that more of the energy latent in our coal-fields will be usefully employed. Some of the coal raised is used for the purposes of the colliery, the rest either with or without further treatment is transported over the country; then it is either burned in the raw state or converted into other fuels by some system of carbonisation, with or without the recovery of by-products. Each process of treatment and each transportation entails the expenditure of energy; the fuel remaining contains less of the latent energy of the coal, but is in a form giving it greater availability.

Coal as mined consists of a mixture of coal and inorganic matter. The large lumps of both coal and dirt are easily separated, but in the past the finer sizes of coal, which often contain a high percentage of ash, have been largely wasted. Improvements in mechanical stokers, and later in the use of pulverised fuel, have made possible the economical use of fine coal even when it has a large ash content. The ash content may easily amount to 10 per cent. or even to 20 per cent. or more, and this not only may cause trouble in the furnaces and in the disposal of the ash, but also necessitates transporting several hundredweights of waste material in every ton of fuel. The importance of this depends on the distance the fuel is moved before burning; if the coal is to be burned at the colliery, it may not be worth incurring the cost of separation, but if it is to be used at a distance, the cost of treatment may be much less than the cost of transporting the ash to the furnaces, heating it up, and carting it away.

For many purposes the presence of impurities such as sulphur or phosphorus is most deleterious, and the problem of their removal is a part of the general question of coal purification. The attention now being paid to this question should lead to a smaller proportion of fine coal being left in the mine and a larger proportion of the coal raised being usefully employed.

Some 40 per cent. of the coal consumed in Great Britain is burned in the raw state under boilers, and the average efficiency of the boiler plants leaves much to be desired. This point was discussed in a recent issue of NATURE (June 7, p. 810); it is unnecessary to go into details here, but there is certainly room for great improvement in this direction, and this will come when users realise the importance of efficient supervision in the boiler-house and efficient maintenance of the plant.

There are two large industries dealing with the carbonisation of coal, and there is much talk of a third being started. The oldest of these is the metallurgical coke industry, which is of vital importance to our iron and steel manufacturers. Here, too, great advances may be hoped for in the future. Old as is the industry, there is still much to learn concerning the essential differences which make one coke more valuable than another for metallurgical purposes, the properties required in the coal for the production of good coke, and the best methods of production with due regard to blending and the conservation of the by-products. The second carbonising industry is concerned primarily with coal-gas production, but yields also important by-products in coke and coal-tar. The Gas Regulation Act of 1920 gave a great impetus to the more economical manufacture of gas; the benefits resulting from the Act and from the experiments of the Fuel Research Board and others will become increasingly evident as time goes on.

The third industry, which may become of great importance in the future, is that dealing with low temperature carbonisation, where the products are a smokeless solid fuel for domestic and industrial purposes, a comparatively large yield of tars which in turn yield fuel oil and motor spirit, and a comparatively small but not negligible yield of gas. The advantages and difficulties of this process are discussed at some length elsewhere in this issue (p. 920).

There remains for consideration the steadily increasing use of liquid fuels—heavy oils for steam raising, and both heavy and light oils for internal combustion engines—mostly for transportation purposes. The advantages of fuel oil for steam raising at sea are that it makes for ease and speed of bunkering, is easy of stowage, there is a reduction of labour all round, ready control and great flexibility, the results being that oil fuel has almost replaced coal in the Royal Navy and the tonnage of vessels on Lloyd's Register which are fitted for burning oil fuel has increased nearly twelve-fold between 1914 and 1923. The possibility of producing from coal an appreciable proportion of the oil required is one of the main reasons why low temperature carbonisation would be of great national importance if developed on a large scale. There are, however, other means by which liquid fuel may conceivably be obtained from coal; the possibilities indicated by recent work on hydrogenation of oil and coal should be given serious consideration.

These processes all result in the conversion of the coal into forms of fuel of higher availability, but some of the original energy is necessarily dissipated in the process. The availability of any form of fuel depends on both the efficiency and the ease with which its energy can be applied and controlled, and this again depends on the purpose for which it is used. The availability is reflected in the prices which consumers are prepared to pay for a unit of energy in the various forms. A treatment or conversion will not be economically sound unless the price obtained for the products covers the cost of the energy, labour, and plant used in the process as well as the cost of the raw material.

One of the important problems awaiting solution is how to avoid the smoke nuisance which results from the burning of raw coal, more especially in domestic grates, in the smaller industrial plants, and in certain metallurgical furnaces. Dr. Ferranti remarked recently that the ideal solution of this would be to abolish the burning of any fuel in populous areas, and to supply all the necessary power, heat, and light from large electric generating stations on the outskirts. From many points of view this would be excellent, and so far as the supply of power and light are concerned it might prove economical; but as regards heat it would mean that, at the outside, 20-25 per cent. of the energy of the coal burned would be available, while it is easy to get three times this efficiency for such purposes as heating water when coal or coke is burned direct. The conversion of the energy of the coal into electrical energy without the intervention of a heat engine might lead to an efficiency of conversion which would make the use of electricity practically universal, but the possibility of this appears almost as remote as the utilisation of atomic energy.

A more probable line of development would seem to be one which confines the burning of raw coal, elsewhere than at the collieries, to large and efficient power stations, and converts the remainder to coke of sorts, liquid fuels, or gas. At the same time the coal as produced would be carefully cleaned, graded, and blended so that the different qualities of coal would be used for the purposes for which they were best fitted, with a minimum of waste. For this ideal to be reached much investigation is still necessary. Far more knowledge is required as to the properties of the coal in the various seams, the relative quantities of the different classes which are available, and the most appropriate treatment for each class, and all speed should be made in pursuing these inquiries.

Psychology.

(1) *The Practice and Theory of Individual Psychology.* By Alfred Adler. Translated by Dr. P. Radin. (International Library of Psychology, Philosophy, and Scientific Method.) Pp. viii + 352. (London: Kegan Paul and Co., Ltd.; New York: Harcourt, Brace and Co., Inc., 1924.) 18*s*. net.

(2) *Essays in Applied Psycho-Analysis.* By Dr. Ernest Jones. (The International Psycho-Analytical Library, No. 5.) Pp. vi + 454. (London: G. Allen and Unwin, Ltd.; Vienna: International Psycho-Analytical Press, 1923.) 18*s*. net.

(3) *Psychology and Morals: an Analysis of Character.* By J. A. Hadfield. Second edition. Pp. vii + 186. (London: Methuen and Co., Ltd., 1923.) 6*s*. net.

(4) *Abnormal Behavior, Pitfalls of our Minds: an Introduction to the Study of Abnormal and Anti-Social Behavior.* By Dr. Irving J. Sands and Dr. Phyllis Blanchard. Pp. ix + 482. (London: G. Routledge and Sons, Ltd., 1923.) 16*s*. net.

PSYCHOLOGY is with difficulty seeking recognition as a science, and the books before us suggest some reasons for the difficulty. Its tenets are often a matter of personal predilection and it has not yet obtained the right, conceded to other sciences only after bitter struggle, to pursue its aims irrespective of prejudice or the supposed moral or immoral sequelæ of its findings. Adler (1) exemplifies the personal element at its strongest, and opens with a preface which repels by its claim of the infallibility of individual psychology—that is to say, of the psychology of Adler. "We shall never agree," he says, "to change the fundamentals of human psychology which it has established and to adopt others in its stead."

Adler's "will to power" covers an aspect of the psycho-neuroses which must be studied, but it is ridden to death when he presents the motives of the melancholiac in terms of conscious processes. "He shows his weakness and the necessity for helping him in the most agonising manner, so that he may either force or mislead others to aid him," and "It is always a question of effect upon the environment." These views would be dreadful if expressed by an asylum attendant. Adler's other main contribution to theory is his conception of "organ inferiority," which here finds expression in a compound of bad translation and clinical phantasy, as in the emphasis of "the inferiority that affects the whole dorsal side of the rump expressing itself as a primary weakness of urine, stool, and semen discharge, that frequently can be overcome and hyper-compensated, and clearly is connected with an inferiority of the spinal marrow in the region of the lumbar vertebræ," which in an unexplained way is "of importance for tabes." Organ inferiority as a factor in the psycho-neuroses appeals to that sentiment which, regarding any anatomical explanation as better than none, is responsible for many discarded hypotheses, from the wandering womb of hysteria to the commotion theory of shell-shock. There is plenty of shrewd observation in the book, but great discrimination is required of the reader.

(2) Dr. Ernest Jones is frankly speculative, and the reader is expected to accept psycho-analytical principles before accompanying him on his explorations into human motives. Want of appreciation of this point of view has led critics to judge the work as an attempt to establish the postulates upon which it depends. The essay on Hamlet, for example, has been taken as an attempt to prove that Shakespeare had an incestuous love for his mother, whereas Dr. Jones assumes such an influence, with a death wish directed towards the father, as a commonplace in unconscious mental development. An intuitive penetration had revealed to the poet, though not to his conscious intelligence, his particular form of the universal conflict, and led him to create a story in which Hamlet found an insoluble problem in the task of avenging a crime which accorded with guilty wishes in his own unconscious. The general postulate being granted, this is a legitimate speculation.

The essay on war and individual psychology is worth study by those who seek a peaceful end of international disputes. Cautious in regard to positive guidance, it leads to the conclusion that the motives of war are never what historians, or even the participators, believe them to be, but in examining the sources of the war impulse it holds out the hope that man may understand himself better. Other essays are concerned with unconscious influences in art and religion, and there is an exhaustive study of the symbolic significance of salt.

Freud's theories have been much altered by those who fit them to their own likes or dislikes. Dr. Jones, almost alone amongst English writers, authoritatively presents them, and to those who accept and understand the theories his book will be welcome; others had better begin on something easier.

(3) Dr. Hadfield reminds one of the days when it was thought necessary to reconcile biological theory with pre-existing ideas. He draws freely upon McDougall and accepts a great part of psycho-analytical theory, but it is time that serious writers ceased to repeat that Freud argues that our conduct is "all sexual," and the allusion to a Freudian who "declares that men fear the Zeppelins, not because of their danger to life, but because of their phallic symbolism representing sexual desires" (p. 16), seems

to be a grotesque perversion of a statement in Stoddart's "Mind and its Disorders" (Lewis, 1921, p. 217).

The author makes it difficult to tell which is psychology and which morals, and is at pains to show that the moral law is a demand of our own psychology—"it is written on the tables of our hearts." But he falls back upon the proviso that "society rightly condemns and ostracises those who act contrary to these laws." He tends to believe what he thinks ought to be, as that the life of the savage is psychologically "far more chaotic than the ordered life of civilised man, whose instinctive forces are directed to a common purpose." This statement looks like cheery optimism, but becomes depressing on closer consideration. The book will do good to those who see in the study of unconscious processes a threat to social stability.

(4) Drs. Sands and Blanchard find no problem in the relation of psychology and morals, but go straight to the practical question of how to use psychological knowledge in the handling of the social misfit—the insane, the drug addict, the delinquent, the psychoneurotic, or the "difficult" child. In spite of Hamblin Smith's account of the co-operation of law and psychology in the courts at Birmingham ("Psychology of the Criminal": London, 1922), a proposal to investigate the mental state of the delinquent is in Great Britain often regarded as an attempt to defeat the aims of justice. Such co-operation seems to be a commonplace in America, and this book is written as a text-book for social workers and also to demonstrate the help that psychology affords in these problems.

The book covers too much ground to give more than a superficial account of either practice or theory, especially as a considerable space is given to case descriptions, but a full bibliography is provided at the end of each chapter. To congratulate the writers upon an absence of enthusiasm seems a poor compliment, but books of this nature are often more enthusiastic than helpful; sober descriptions and free acknowledgment of limitations are welcome characteristics in a popular book on psychological matters. MILLAIS CULPIN.

Low Temperature Carbonisation.

(1) *Low Temperature Carbonisation.* By S. N. Wellington and W. R. Cooper. Pp. ix+238. (London: C. Griffin and Co., Ltd., 1924.) 25*s.* net.

(2) *Low Temperature Carbonisation.* By Dr. C. H. Lander and R. F. McKay. Pp. 277. (London: Ernest Benn, Ltd., 1924.) 35*s.* net.

THE question of the low temperature carbonisation of coal is arousing ever-increasing interest, the problems involved are far more complicated than appear at first sight, and many statements have appeared in the press, which, if not definitely inaccurate, are still misleading to those who have not studied the question. For these reasons the appearance of the two books above mentioned is very timely. Both books are well written and produced, and deal with the problem in an unbiassed spirit.

The objects of low temperature carbonisation are twofold, namely, to produce a smokeless solid fuel, easily ignited and suitable for domestic and industrial purposes as a substitute for raw coal, and the production of a supply of oils from home sources. When raw coal is burned in the ordinary domestic grate (and some 35 million tons are so used in Great Britain each year) a considerable amount of unburned products, including smoke, is discharged through the chimney, thus causing the loss to the community in health and expenditure in washing, artificial lighting, etc., which results from atmospheric pollution by smoke. The same evils result, though possibly to a less extent, from the use of coking coals in hand-fired industrial boiler plants. The coke resulting from low temperature carbonisation not only produces no smoke when burned under such conditions, but is also more completely consumed, so that the thermal efficiency is higher than that obtained from raw coal. It may thus eventually be found that smokeless fuel has, for many purposes, a higher practical value, compared with an equal weight of raw coal, than would appear from a consideration based only on their relative calorific values.

The use of liquid fuels has increased with great rapidity in recent years. The Navy is now practically dependent on fuel oil; the mercantile marine is also using more and more fuel oil, as the advantages in ease and rapidity of bunkering, and ease of control in the stokehold, are very great. The use of diesel engines is increasing, and the demand for motor spirit is insistent. At present, practically all the liquid fuel used is imported, and even where the source of supply is under British control, the transport is a serious matter. Important as these conditions are in peace-time, they become even more so in war.

By carbonising suitable coals at temperatures round about 600° C., a yield of some 14-15 cwt. of smokeless fuel, 15 gal. of tar, and 3 gal. of motor spirit can be obtained from each ton of coal, together with some 30 therms of gas. The amounts vary according to the coal used and the process adopted. The quality of the gas may vary from a calorific value of more than 1000 B.Th.U. per cub. ft. when the retorts are externally heated, down to less than 250 B.Th.U. when the retorts are internally heated. It is seen at once that if the whole of the coal burned in the raw state in domestic appliances were replaced by low temperature coke, the advantages to the nation would be very great, and that the subject is one deserving the closest attention.

The difficulties in the way of successful development are largely economic; half-a-dozen different processes have proved capable of producing good smokeless fuel with oil recovery when using suitable coals, but no one has yet proved that a process has been developed which is economically successful on a really large scale.

One of the economic difficulties results from the fact that the products of low temperature carbonisation all compete directly on the market with other materials. The coke competes with raw coal, the tar products with those obtained from natural oils, and the gas with that produced by other processes. When the process is carried out on a small scale, it may be possible to utilise grades of coal for which there is little demand and therefore obtainable at a very low rate, and to produce a smokeless fuel which will sell at the price of the best household coal; the low temperature tars have qualities which make them specially suitable for certain industrial purposes, such as the manufacture of disinfectants or paints, for which purposes they command a price considerably in excess of that of fuel oil. Hence small-scale working may show good profits. As soon as the process is adopted on a scale large enough to produce any effect on the oil supply, the financial conditions alter. A demand is at once created for coals previously unsaleable, and, equally important, the demand for household coal will diminish, and this is the class of coal fetching the highest prices at the pit-head; this will cause a loss to the collieries which must be made good in other ways; hence the price paid for the coal to be carbonised cannot be much less than that of household coal if low temperature carbonisation is carried out on a national scale. The tar will only sell at the price obtainable for fuel oil, as the market for special purposes is strictly limited. Under these conditions, the balance to meet capital and working costs is very small, and success can only be obtained if these are kept down, and then only if the smokeless fuel can be sold at a higher price per ton than the coal used. It has already been shown that it is not altogether unreasonable to hope that this will prove possible, but the margin will not be large.

Although much work has been done in the last fifteen or twenty years, our knowledge of many of the fundamentals underlying the process is still very incomplete. Coal is a complex substance and its composition varies greatly. Coals which give very similar results when analysed by the usual methods may have very different coking properties. Some coals swell when carbonised and yield a porous frothy coke with no strength, others yield a firm compact coke, while others again yield an incoherent powder; suitable blending of strongly coking with non-coking coals will yield good coke. Much work remains to be done on the structure of coke and the method of its formation, and the factors which really determine its "combustibility" and "activity" are still largely unknown.

The composition of the tar depends on the coal used and the process of carbonisation adopted; there is still much to be learned as to the effect of variations in the temperature and speed of carbonisation. Generally speaking, low temperature tar may be expected, according to Lander and McKay, to possess the following general characteristics:

"(1) That it will contain hydrocarbons chiefly of the paraffin and olefine series with some naphthenes and from 10 to 15 per cent. of phenols.

(2) That the quantity of benzene and its homologues will be small, but will be made up for by the presence of light paraffins, such as hexane, etc.

(3) That the higher phenols, such as cresol, will be more represented than phenol itself, and there will also be present certain polyhydric alcohols.

(4) That the content of free carbon will be less than 2 per cent., and that of pitch will be 35-40 per cent.

(5) That there will be up to 1 per cent. of basic nitrogenous substances, including pyridine."

The crude tar can be used as a fuel oil or, if dehydrated and freed from suspended solid matter, as a diesel oil, but suffers from the grave disadvantage that it is not miscible with most natural oils. This can be overcome by fractionation and refining, when good fuel and lubricating oils are obtained, or some of the pitch can be removed by the Lessing process, in which the pitch is precipitated by treatment with petroleum spirit: the crude oil resulting is miscible in all proportions with natural oils.

The technical difficulties result largely from the low thermal conductivity of coal and the consequent difficulty in getting the heat into the coal. A high temperature gradient cannot be used, or some of the coal will be overheated; consequently, if externally heated retorts are used, the coal must be carbonised in thin layers, or it must remain in the retorts for a long period, and either alternative tends to lower the throughput of the plant and thus raise the capital costs. The use of small retorts also increases the cost of labour in charging and discharging. This difficulty can be overcome by using retorts in which the coal is carbonised by the sensible heat of inert gases passing round it. If non-combustible or low-grade gas be used for heating by this method, the gas produced by the carbonisation is diluted, and consequently its value per therm is reduced. If an attempt be made to use high calorific gas for the heating, this gas is necessarily subjected to rather high temperatures. This leads to cracking some of the richer constituents, and so again reducing the calorific value of the gas finally available.

The material of which the retorts are made requires careful consideration, and Lander and McKay deal with this and other practical points in a chapter headed "Some Difficulties Encountered." In high temperature carbonisation the use of refractory materials for the retorts is necessary, but these are poor conductors of heat, and retorts made from them are difficult to keep gas-tight at "low" temperatures. Metal retorts give better heat transference and are more easily kept gas-tight, but unless care is taken as to the composition of cast iron, where such is used, there will be trouble from "growth." Mild steel can be used up to temperatures of 600° C., but above that the material softens; alloy steels can be made to stand higher temperatures, but they are at present expensive and this naturally hinders their adoption.

Attempts have been made to increase the rapidity of carbonisation by keeping the coal moving so that fresh surfaces are continually being brought into contact with the hot sides of the retort, but this results in the coke being broken up to a degree which renders it unsuited for use as a domestic fuel.

(1) Messrs. Wellington and Cooper's book might be improved by an extension of the chapters dealing with laboratory work and theoretical considerations. The work carried out by the Fuel Research Board has been strangely ignored. The book contains an interesting chapter on the generation of electrical power, and the possibility of recovering the oil from the coal used for this purpose.

(2) Dr. Lander was formerly assistant to Sir George Beilby, and succeeded him when Sir George retired from the position of Director of Fuel Research under the Department of Scientific and Industrial Research, and Mr. McKay is his colleague in the Department. This fact, as Sir George points out in a foreword, places the authors in an almost unique position when writing a book on this subject. The result is an excellent, comprehensive, and judicial book which must be considered as the standard work on this important subject.

The Teaching of Palæontology.

Outlines of Palæontology. By Prof. H. H. Swinnerton. Pp. xii+420. (London: E. Arnold and Co., 1923.) 30*s.* net.

THE "Palæontology" of the title would more correctly have been "Palæozoology," but Prof. Swinnerton doubtless chose the former intentionally because he declines to regard his subject as a mere division of zoology. He does indeed deal with his material in the order of the zoological system, from Protozoa to Primates; but instead of that museum-like arrangement under orders, families, and genera which deadens the usual systematic text-book, he selects in each phylum or class certain characters and traces their origin, progress, and decline. The declaration by a professor and a potential examiner that it is more important for a student "to recognise the evolutionary stage attained by one or more of the individual features in his fossil" than to identify its species or even genus deserves cordial welcome, for a facility in winning marks by fossil-spotting argues a misspent youth.

Here then are no pretty pictures of fossils, but plenty of diagrams reduced to the simplest elements, with some interesting charts and graphs. Thus, for palæozoic echinoids we are shown seven stages in the evolution of ambulacral plates and areas, four stages for interambulacral areas (the lettering unfortunately reversed), and a graph contrasting three genera; and we are then invited to construct similar graphs for the other genera and to decide for ourselves how far the classification is a natural one. In this way the study of each group is made to bring out some broad principle, and all these principles of structural change are summed up in a concluding chapter, which would be improved by the insertion of references to the pages on which the evidence for its assertions has been detailed.

All this is excellent, for a study of the changes passed through by any one structural element is an illuminating method peculiar to palæontology. But to speak of such a series of changes as "the palæontologist's independent unit" (calling it by the hybrid term "Bioseries"), and to emphasise repeatedly "the independence of structural elements," is surely to go too far. By his concluding section on "The Co-ordination of Bioseries," Prof. Swinnerton proves himself alive to the danger of regarding a race as a bundle of distinct and possibly warring tendencies; but the student of fossils should always have before his mind the concept of the living organism, a concept that embraces, not merely its own structures and internal tendencies, but all that part of external creation which is in relation with the apparently isolated creature. The environment is not indeed ignored in this interesting book, but it does not appear in many places where one looked to find some mention of it; and the environment of a single organ includes all the rest of the body. Neither in the macrocosm nor in the microcosm is there such a thing as independence.

F. A. BATHER.

Our Bookshelf.

Petrographic Methods and Calculations. By Dr. Arthur Holmes. Part 1: Specific Gravity, Separation and Determination of Minerals, Detrital Sediments. Pp. xv+230. Part 2: The Study of Thin Sections. Pp. xiii+231-383+4 plates. Part 3: Chemical Methods and Calculations. Pp. xiii + 384-515. (London: T. Murby and Co., 1923.) Part 1, 15*s.* 6*d.* net; Part 2, 10*s.* 6*d.* net; Part 3, 8*s.* 6*d.* net.

These attractive and handy volumes, which cover the whole field of practical petrology, present in the form of convenient "Parts" the matter contained in the original treatise which appeared three years ago as a single volume. They deal separately with the three divisions into which the subject naturally falls, according as the methods described concern (*a*) raw material, such as rock specimens, crushed rock, or loose detritals; (*b*) material mounted for study under the microscope; and (*c*) chemical analyses.

Part 1 is designed to meet the special needs of the stratigrapher and the worker in sedimentary petrology. It contains 12 tables of data, and numerous illustrations. Part 2 deals exhaustively with determinative work (petrological, microchemical, and micrometric) based on thin slices of igneous, sedimentary, and metamorphic rocks. Nine figures appear in the text, and 25 admirable microphotographs, appropriately described, form a useful appendix. Part 3 expounds with clearness and precision the methods whereby analyses of both minerals and rocks may be probed for characteristics and other significant data. The text is well illustrated and two appendices assemble in convenient form numerical data and tables for purposes of calculation.

The treatise as a whole presents an excellent epitome of the methods which have been employed with any degree of success in the past. Moreover, it is rich in suggestions for extending or adapting such methods to new problems, academic or industrial. The student will be stimulated by it; the research worker will find in it both guidance and help.

A. B.

Laboratory Studies in Mammalian Anatomy. By Prof. I. W. Wilder. Pp. xi+157. (Philadelphia: P. Blakiston's Son and Co., 1923.) 2 dollars net.

The work under notice is designed, primarily for medical students, as a guide to a course of practical work in mammalian comparative anatomy and histology, to accompany a series of lectures on human anatomy and physiology. This broadening of the anatomy course for medical students deserves at least passing emphasis. The book, however, should be of service in a wider field. The course is specially based on the smaller mammals, such as the rabbit, guinea-pig, and white mouse, which are easily bred in the laboratory, and on such parts or organs of the larger mammals as are readily obtainable through the agency of the local slaughter-houses and abattoirs, constant reference to and comparison with the human body being made throughout. The author's choice of material for dissection certainly minimises the expense, a question of practical importance where large classes have to be catered for. The book is, therefore, eminently suitable as a text-book of junior anatomy for veterinary students. It should also be of great practical value to the university student of zoology, though it includes rather more work than can be done conveniently in an ordinary degree course. The exercises, however, admit of condensation in the form of demonstrations by the teacher, without loss of continuity to the whole. With this possible use of the book before him, the author has modified the Basle Anatomical Nomenclature as applied to human anatomy to meet the needs of the student of pure zoology. The directions are clear and concise, and the instructions on such matters of technique as injections and the preparation of sections for histological study of great practical value.

Mechanical Stoking. By David Brownlie. (Pitman's Technical Primers: Double volume.) Pp. x+234. (London: Sir Isaac Pitman and Sons, Ltd., 1923.) 5*s.* net.

The author of this work is well known from his published reports of experiments and investigations on steam generating plants; he has had experience with every type of mechanical stoker used in Great Britain, and his views as expressed in the volume before us may be taken as authoritative. Practically the whole of the modern principles of mechanical stoking were understood and applied on a large scale by the year 1845, when it began to be recognised that mechanical stoking, besides minimising black smoke, tended to do away with the laborious and unpleasant jobs of hand-firing and fire-cleaning. The book contains a large amount of excellent descriptive matter such as should be of value to the boiler owner, who may not be an engineer, in the understanding of the various types of stokers; sufficient also is given regarding the proper working conditions to be aimed at in the plant. The question of the efficient burning of coal is of national importance, and this little book should help to lead to a more intelligent appreciation of the problem.

Historja Naturalna Lodu (Histoire naturelle de la glace). By Antoni Boleslaw Dobrowolski. Pp. xvi +940. (Warszawa: J. Mianowskiego, 1923.) n.p.

It is a pity that a volume which deals with so important a field of research should be published in a language that in all probability will render it useless to those who are most interested in the subject. The author, who many years ago sailed as meteorologist with the Belgian Antarctic Expedition, has produced a detailed monograph on the origin, nature, and properties of ice, paying relatively little attention to its climatic and geographical aspects. From a disappointingly brief French summary, we gather that his aim has been to collect the main problems which atmospheric and terrestrial ice present, with special reference to recent researches on the movements of ice and the crystallography of ice. There are detailed tables of contents in French, and with these most readers will have to be content unless they find the copious bibliographies of use. The latter, however, have some notable omissions, which are partly accounted for by the fact that the book was completed in 1916 but not printed until 1923. There are many illustrations of ice structure.

Letters to the Editor.

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Collisions between Light-quanta.

THE equations which have been applied so successfully by A. H. Compton[1] and P. Debye[2] to encounters between electrons and light-quanta may be applied in a slightly modified form to an encounter between two light-quanta. It seems better, however, to consider first the result of supposing that the encounter results primarily in the production of a localisation of energy which can be represented by a moving particle of stationary mass m.

Assuming that quanta (of energies $h\nu$ and $h\nu_0$) moving initially along lines the directions of which may be specified by two unit vectors s and s_0, coalesce into a particle of mass m moving with velocity v, we have the equations

$$c(\nu s+\nu_0 s_0)=(\nu+\nu_0)v,$$

$$\frac{mc^2}{\sqrt{1-\frac{v^2}{c^2}}}=h(\nu+\nu_0), \quad . \quad . \quad . \quad (1)$$

where h is Planck's constant.

Drawing lines OA,OB of equal length c in the directions of motion of the quanta and a line OP of length v in the direction of motion of the particle, we notice that the points A,B,P are collinear and that νPA$=\nu_0$PB. The same construction applies also to the case in which a moving particle of mass m breaks up into two quanta travelling in the directions OA and OB.

It is a significant fact that the above construction is identical with one used previously by the author[3] in the study of certain electromagnetic fields in which electric poles or dipoles, travelling with the velocity of light, are projected from a moving point. This is, indeed, a slight indication that there may be some connexion between light-quanta and projected dipoles.

The construction is related also to Pauli's idea of normal co-ordinates.[4] By making a suitable Lorentzian transformation, it is possible to study two impinging entities relative to a system of normal co-ordinates in which their momenta are equal and opposite. This means that in our case the resulting particle will be stationary. The velocity v of the Lorentzian transformation is found to be identical with the velocity v defined by equations (1). The direction of the velocity may be determined by the following construction, which is sometimes useful. Let SQ,QS′ represent the momenta of the quanta in magnitude and direction, then SS′ represents the momentum of the resulting particle and c(SQ+QS′) its total energy. If the particle now explodes, producing two new quanta, the momenta of these quanta may be represented by SR,RS′ respectively, where Q and R lie on a prolate spheroid with S and S′ as foci.

A similar construction may be applied to two particles with stationary masses m and m_0 respectively. The total energies of the particles before the encounter are represented by $c\sqrt{m^2c^2+\mathrm{SQ}^2}$ and $c\sqrt{m_0{}^2c^2+\mathrm{S'Q}^2}$ respectively and, if the total energy and momentum of the resulting particle are given, the locus of Q is a spheroid, but this spheroid no longer has S and S′ as foci.

The first of the equations (1) arises also in the investigations relating to the lines of force of a moving electric pole,[5] and it may be that there is some way of applying the correspondence principle to the impact of pairs of quanta, using the electromagnetic field as a guide.[6]

If we suppose that a localisation of energy is produced temporarily by impinging quanta, the particle of localised energy may be built up from a number of collisions before an explosion occurs, which results in the emission of pairs of quanta. If the particle also contains localised energy in the form of electrons, an explosion may result in the emission of an electron and a quantum as in the Compton effect. Compton's equivalent velocity is, in fact, that of a particle which can absorb the electron and light-quantum without any change in its own momentum and emit them again without losing momentum. It is this particle which is the moving primary singularity when we wish to build up an electromagnetic field from scattered radiation and use the correspondence principle as Compton has done.

Since an electron is accelerated in an electromagnetic field, it seems likely that it absorbs quanta (or electric dipoles) one by one and normally emits them in pairs or in some manner which on the average amounts to this. In producing an electromagnetic field an electron may, in fact, emit an enormous number of dipoles in all directions in a very short time without losing momentum, and the simplest way of picturing this emission is to think of it as taking place in pairs so that the continuity of the motion of the electron is preserved. But this may be only a convenient mathematical device, and the electron in reality may be moving along a zigzag path while it emits dipoles one at a time. If this be the case, the emission of a single quantum in one direction differs only from the other emissions in degree, the quantum jump being simply a large step in the zigzag path. The question whether the quantum is to be pictured as a single dipole or a chain of such dipoles must be left open. Attempts have been made to form a theory in which groups or chains are built up of unit dipoles,[7] but the idea has also been found useful that two unit dipoles may combine to form a dipole of larger moment.[8]

The word dipole is used here as a convenient term for the elementary type of entity which produces electric force. It consists of two particles of electricity, if we adopt primarily as our definition of a particle of electricity, the simple one that it is an entity which theoretically can be recognised and specified mathematically by three parameters which remain constant during its motion.[9] H. BATEMAN.

California Institute of Technology,
Pasadena, California, May 29.

1 *Phys. Review*, vol. 21, pp. 207 and 483 (1923), vol. 23, p. 439 (1924).
2 *Phys. Zeitschr.*, April 15 (1923).
3 *Mess. of Math.*, May (1915), March (1918); Proc. London Math. Soc. (2), vol. 18 (1919), p. 95.
4 *Zeitschr. f. Phys.*, Bd. 18, p. 272 (1923).
5 *Amer. Journ. of Math.*, April (1917); F. D. Murnaghan; H. Bateman, *l.c.*
6 The principle of Huygens suggests that collisions between the entities producing a radiation field may actually occur.
7 *Phys. Review*, vol. 17, p. 64 (1921); Bull. Amer. Math. Soc., vol. 27, p. 217 (1921).
8 Publications of the Astronomical Society of the Pacific, vol. 34, p. 94 (1922).
9 Bull. National Research Council, vol. 4, Dec. (1922).

An Experimental Effect of Light on the Sponge, Oscarella.

THE spicule-less sponge, *Oscarella lobularis*, is an interesting form found on our shores and elsewhere, and presents a wide range of colour variation. Topsent (*Arch. de Zool. Exp. et Gén.* 3, iii., 1895) has recorded that Oscarella when found exposed fully to light is deep red, as when growing on the stem of the weed

Cystoseira or on the sides of rocks, and brownish- or even greenish-yellow when growing in dark situations, as on the under side of stones. At Plymouth, a similar range of colour variation is found, while colonies which are overgrowing the under sides of stones and extending over the edges show a development of red colour where the sponge is exposed to direct light.

The shade of colour of the sponge is found to vary with its condition, apart from that caused by varying illumination; it is darker when deflated and much lighter when inflated with water with the osculæ fully extended. It was thought worth while to place yellow-toned colonies in the large shallow tank in this laboratory to test the effect of direct light on them. The results of the experiment are so clear as to be worth recording. Browny-yellow colonies (No. 157 sample of "Code des Couleurs," Klinksieck et Valette, 1908) were found to blow out at once when put in sea-water and give a lighter browny-yellow colour, rather lighter than shade Nos. 177 and 182 of the "Code" (the numbers given in brackets below are also those of colour shades from the same book). When exposed to a good south light in about four inches of water, these colonies in the inflated condition changed to a dark orange (112 to 117) in 9 days in Feb.-Mar., a pinky orange (*ca.* 92) in 13 days in Mar.-April, a blood orange colour (*ca.* 82, but partly deflated) in 21 days in Feb.-Mar., a salmon pink (*ca.* 71) in 20 days in early May, but to a salmon pink (91) in 8 days in late May. In the latter case the deflated sponge after $1\frac{1}{3}$ hours out of water looked a dark-red orange colour (87 to 82). Four days later the same colony had changed to a deep salmon (71 to 66) while inflated and to a darkish cherry (mainly 57) when deflated after $\frac{1}{2}$ to $1\frac{1}{2}$ hours out of water, and approached in shade very closely to the red sponges exposed to direct light on the shore. The pink colonies are healthy-looking, show normal appearance in microscopic sections, and active flagellæ in teasings of the fresh tissues.

Other colonies were kept at the same time in the dark but were repeatedly eaten up—as were those in the light—until a suspected *Pleurobranchus plumula*, the lemon sea-slug, was opened and found with a stomach full of Oscarella. In May, however, browny-yellow colonies were isolated in a bowl in a current of sea-water in a fairly dark place, and were found to have undergone little change, while the similar colonies exposed to direct light in the same period had become distinctly pink to red-orange. One of the colonies near the top of the bowl which received some light was found, however, to show a suspicion of pink coloration. It is clear, therefore, that Oscarella from dark situations is rapidly affected by light, acquiring eventually a red colour, while the May experiment indicates that the rate of the colour-change is dependent on the intensity of the incident light.

Some yellow colonies were also marked on Feb. 25 and left in the sea on upturned stones exposed to direct light on the shore, but after March 7, when two had changed to orange (132) and liver-colour (112) respectively, they all disappeared, presumably having been eaten up. Some other colonies marked later on the shore in the same way also disappeared. A red colony (32 deflated) on a rock was covered over with stones to shut off direct light, but no colour-change was observed in this case in two months (March-April). If it could be confirmed that yellow Oscarella is actually eaten up quickly when present on the tops of stones exposed to light, but flourishes on the under sides of stones in the same situation, the observation might furnish a hint of the possible use of colour, or properties associated with colour, in repelling enemies, but too little is known about the matter to dogmatise. For example, a species of Clathrina at Plymouth occurs in white, yellow, and red colour varieties, but in this case the red variety is always *under* stones in rock pools, generally in dark situations, while the white will sometimes change to light sulphur yellow in the course of transference from the shore to the laboratory. The relation of colour variation to environment in this form awaits further observations on the exact conditions on the shore in which each colony is obtained. A form of Halisarca, which occurs on the shore and is sometimes confused with Oscarella, does not develop red colour when exposed to light alongside Oscarella; while *Hymeniacidon sanguineum*, which occurs naturally in light to deep shades of orange, gradually loses its red component when exposed to direct light, and eventually assumes a merely pinky-yellow colour.

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The Theory of Hearing.

DR. HARTRIDGE's interesting report (NATURE, May 17, p. 713) of experiments with light pendulums driven by resonance from a heavy pendulum of variable length, states that a careful change in length without interruption of motion resulted in a gradual dying out of non-resonant small pendulums with increased motion of resonant pendulums. The change must be gradual, not interrupted, and carefully made. A sudden change or a single brief impulse would result in irregular jangling. If Dr. Hartridge will hang his small resonance pendulums on a body that gives sudden jerks, he will find that each jerk will produce a jangle. The speech tone from the larynx does not consist of a sequence of pendulum vibrations but of a series of sudden jerks. These jerks do not come at a constant interval in speech but at an ever-changing one. Each jerk would produce in a pendular resonance system a jangle of tones, and the series of jerks would produce only continued jangle. This fundamental fact disposes not only of the harmonic theory of the vowels but also of the resonance theory of hearing.

A vowel consists physiologically of a series of puffs of air from the larynx acting upon a complicated cavity. The puffs of air from the glottis occur at steadily changing intervals, no two consecutive ones being exactly alike. Each puff is a molecular disturbance of a form varying from an aperiodic movement of air to a periodic movement of fading amplitude. When the laryngeal tone consists of a series of sharp puffs, the equation of a single puff is

$$y = a \, . \, e^{-\epsilon t}. \quad . \quad . \quad . \quad . \quad . \quad (1)$$

When the puffs are not so sharp, they consist of movements of a form that may be represented as a sum of frictional sinusoids. The equation of such a puff is

$$y = \Sigma a \, . \, e^{-\epsilon t} \, . \, \sin \frac{2\pi}{T} t, \quad . \quad . \quad . \quad (2)$$

where a, ϵ, and T may have any values needed to make the equation fit the air movement. The period T is *not* the period of the laryngeal tone but of the vibration of the air aroused by a single puff movement.

Each puff acts upon the complicated vocal cavity of the pharynx, mouth, and nose, and arouses vibrations which are communicated to the air in front of the mouth. The vibrations of a single cavity are in the simplest form expressed by one member of equation (2), where a, ϵ, and T are in no way related to the similar values for the laryngeal puff. When the cavity is complicated so that parts of it act with some degree of independence, the vibrations will be of the form (2) with values for a, ϵ, and T different from those for the larynx. The result of the action of one puff from the larynx will be a double sum of the form expressed in equation (2), where a, ϵ, and T have independent values in the two sums.

The actual molecular movement for a vowel likewise consists of the sum of frictional sinusoids from the larynx plus the sum from the vocal cavities.

Such a function has three sets of independent variables and cannot be analysed by any method now known. Even the most accurate curves of a vowel cannot be directly analysed for just this reason. The physical movement itself cannot be analysed by any apparatus, even by a resonance organ in the ear if we had one.

The piano experiment quoted by Mr. Wilkinson in NATURE of May 31, p. 781, demonstrates that piano strings respond only when *not* damped (the fibres of the basilar membrane are heavily damped); that even undamped strings respond only to a few vowels when they are prolonged on a constant tone; that they respond with confused noises to vowels sung portamento; and that they fail to respond to short spoken vowels. As Mr. Wilkinson recognises, the statement "that sounds containing [damped] inharmonic partials are incapable of being completely resonated" would, if true, "completely dispose of the resonance theory of hearing." This is the crux of the whole matter. If my brief statement is not clear, I hope the mathematicians will do better. For the microscopic anatomy of the ear, reference can be made to Prof. Kolmer's section in Alexander and Marburg's "Neurologie des Ohres."

E. W. SCRIPTURE.

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Darwin and Evolution.

MAY I briefly comment on a paragraph in "Current Topics and Events" on p. 866 of NATURE of June 14? The writer of the note, who is evidently an authoritative biologist, expresses himself with more vigour and certainty than I should have ventured on in an alien though admired subject. My claim is that some mental or psychic activity or influence can be inferred from the facts of evolution; but to step from that to the influence and purpose of a Mind with a very big M—though a step natural to faith—is a greater stride than I suppose science alone can ever take: for the intermediate grades of intelligence are perhaps infinite.

In my *Spectator* letter of May 31, on which the note comments, I trust I was not improperly critical of the work of the greatest naturalist. To compare any one with Copernicus, and even guardedly with Newton, is surely eulogistic so far as can be reasonable and right.

OLIVER LODGE.

June 14.

A Method of increasing the Effective Sensitiveness of Galvanometers, etc.

REQUIRING recently to increase the sensitiveness of a mirror galvanometer, I found the following optical method very satisfactory. I have not seen it described previously, but in any case it seems worth while to make it more widely known.

Let the light from a vertical lamp-filament be reflected by the concave galvanometer mirror to a focus in front of a short-focus concave mirror at the principal focus of the latter. The beam is thus reflected again as a parallel pencil, and can be observed by the telescope of a spectrometer. The short focus mirror is mounted on the table of the spectrometer. Instead of a concave mirror a convex lens can be used and the transmitted parallel beam observed, or a convex mirror or a concave lens may be placed similarly between the galvanometer mirror and the focus of the original reflected beam.

If the distance of the galvanometer from the mirror (or lens) is a, large compared with the focal length of the latter, f, if $d\phi$ is the deflexion of the galvanometer mirror and $d\theta$ the angle through which the spectrometer telescope has to be turned to keep the final reflected beam in view, then $d\theta = \frac{2ad\phi}{f}$, if the galvanometer mirror lies on the principal axis of the mirror or lens. In practice this is impossible in the case of the mirror, and if ϕ is the angle of incidence the formula becomes $d\theta = \frac{2ad\phi}{f\cos\phi}$.

Such a magnification is sufficient for many purposes, but the process may be repeated if necessary. Instead of a parallel final beam one uses a slightly convergent one, and allows it to fall on a second short-focus mirror or lens, under conditions similar to those in the first stage of magnification.

Since the beam reflected by the galvanometer mirror is afterwards dealt with as a whole, there is no loss of light save through the imperfections of polish and form of the accessory lenses or mirrors, and it is easy to work in a well-lighted room. The resolving power of the system, with two stages of magnification, is obviously low, but the final image of the filament is still sharp enough for settings to be made to the nearest minute on the spectrometer scale without special precautions.

A few illustrations may be of interest. A galvanometer which gave a deflexion of 1 mm. per $7{\cdot}2 \times 10^{-9}$ amp. on a scale at a distance of about 90 cm., when used in the ordinary way, showed a telescope deflexion of 1′ per 4×10^{-11} amp. when a 1 inch objective taken from a travelling microscope was set up as described on the spectrometer table at the same distance as the scale. Under ordinary conditions, the ballistic throw was 1 mm. for $1{\cdot}9 \times 10^{-8}$ coulomb: with the lens, 1′ corresponds to 1×10^{-10} coulomb. This means that a throw is observable when a coil of a single turn, 7 cm. in diameter, is connected to the galvanometer and turned over in the earth's field. Capacities of the order of 0·001 mfd. can be compared with an accuracy of about 5 per cent. using an ordinary accumulator as the source of potential difference.

The method is obviously available for any type of instrument in which small angular displacements are to be observed or measured.

J. H. SHAXBY.

Viriamu Jones Physical Laboratory,
University College, Cardiff,
June 6.

Comparison of Wave-lengths with a Fabry and Perot Étalon.

IN investigations on the accurate measurement of wave-lengths by means of a Fabry and Perot étalon, it is possible to obtain the desired values without the necessity of measuring the focal length of the optical system. In such work as carried on by Rayleigh (*Phil. Mag.* 11, 685, 1906), Fabry and Perot (*Astrophys. Jour.* 15, 73, 1902), Eversheim (*Astrophys. Jour.* 26, 172, 1907), Pfund (*Astrophys. Jour.* 28, 197, 1908), Brown (*Astrophys. Jour.* 56, 53, 1922), and others, use is made of the relation

$$\frac{\lambda}{\lambda'} = \frac{p'}{p}\left(1 + \frac{x'^2}{8} - \frac{x^2}{8}\right), \quad . \quad . \quad . \quad (1)$$

where λ, λ' are the two wave-lengths to be compared;

x and x' are *angular* diameters of the first rings; and p and p' are the corresponding orders of interference. The problem may be simplified, however, by a variation in the method which requires a measurement of only *linear* diameters. In the simpler method the above expression is replaced by the more fundamental one, from which indeed it is derived:

$$\frac{\lambda}{\lambda'}=\frac{p'+a'}{p+a}, \quad . \quad . \quad . \quad . \quad (2)$$

where a is the fractional part of the number which gives the order of interference for wave-length λ, corresponding to the centre of the ring system. Now the value of a (and a') may readily be obtained from measurements of linear diameters by making use of the relation

$$a=\frac{(n-1)d_k^2-(k-1)d_n^2}{d_n^2-d_k^2}, \quad . \quad . \quad . \quad (3)$$

where d_k and d_n are linear diameters of the kth and the nth rings. This expression, which is a generalised form of one used by Merton (Proc. Roy. Soc. A, 96, 388, 1920) in an investigation on the spectra of isotopes, may be deduced easily from the fundamental equation of the étalon (path difference $=2t\cos x_n$). The accompanying table, in which numbers are calculated from measurements of a plate taken by one of the writer's students, gives an idea of the accuracy of the method.

k.	n.	a.
2	3	0·0581
2	4	0·0581
2	5	0·0579
3	4	0·0584
3	5	0·0577
4	5	0·0565

Mean $=0·0578\pm0·00007$.

The method may be varied by using equation (1) and calculating the value of f, the focal length which determines the angular diameter of a ring from the relation

$$p=\frac{8f^2(n-k)}{d_n^2-d_k^2}+k-1.$$

There is, of course, little, if any, advantage in following this procedure.

JOHN K. ROBERTSON.

Queen's University, Kingston, Canada,
May 20.

On the Centroid of a Circular Arc.

THE usual text-book formula for the radial distance of the centroid of a circular arc of radius r and length $2ra$, may be converted into a useful result by expressing the position of the centroid in terms of its distance from the chord of the arc and as a fraction of the versine of the arc. Thus the usual form

$$\frac{\bar{r}}{r}=\frac{\sin a}{a}$$

converts to

$$\frac{\bar{h}}{h}=\frac{\frac{\sin a}{a}-\cos a}{1-\cos a}.$$

If this is expanded in powers of a we have

$$\frac{\bar{h}}{h}=\frac{\frac{1}{3}-a^2(1/30)+a^4(1/840)-}{\frac{1}{2}-a^2(1/24)+a^4(1/720)-}$$
$$=\tfrac{2}{3}\left(1-\frac{a^2}{60}+\frac{a^4}{1260}-\ . \ . \ .\right).$$

Thus for flat arcs the centre of gravity is at $\frac{2}{3}$rds of the vertex of the arc, and for an arc of 2 radians the error is only 1·5 per cent. Even with a semicircle this value is in error by only about 6 per cent. This result is the more interesting, because no simple curve except the straight line has its centre of gravity at a height proportional to the terminal ordinate.

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15 Bolton Road,
Chiswick, W.4, May 26.

Einstein and Mach.

IN the issue of NATURE for August 18, 1923, p. 253, Prof. Einstein is quoted as having said of Mach, at the reception given to him (Einstein) by the Société Française de Physique, "His (Mach's) view of science, that it deals with immediate data, led him to reject the existence of atoms. Probably were he still with us he would change his opinion." As one of the oldest pupils of Mach who worked with him on fluorescence in 1877 and enjoyed his warm friendship since 1876, I often had an opportunity of discussing atomism with him. Not long before the War, I was sitting with him in his garden in Vienna, and I remember that he said to me: "Atomism is a good working hypothesis for the study of chemistry; it must be used with great care on studying and working in science; but it is extremely dangerous as a noetic theory." It was after the memorable discovery of Rutherford and Geiger in 1908, who showed that the emission of a-particles from radium-C is the same whether it be counted by the spinthariscope or by the electroscope, and the most incredulous chemists admitted it as a proof of the existence of atoms, that Mach did not change his old view. At the beginning of the War, I asked him in a letter whether he considered the results of all the observations in radioactivity as a proof of the existence of atoms, and he replied to me verbally: "I do not make myself a proselyte of my ideas—do not make yourself a proselyte on atomism." He never changed his ideas up to his death.

BOHUSLAV BRAUNER.

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Approximate Integration.

THE following rule for approximate integration generally gives almost as good results with four, seven, or ten ordinates as Simpson's does with seven, eleven, and fifteen respectively.

$$\int ydx=h\{2(y_2+y_6+y_{10}+\ . \ . \ .)+(y_3+y_5+y_7+\ . \ . \ .)\}.$$

The rule is obtained by applying the trapezoidal rule to the ordinates y_1, $2y_2-\frac{1}{2}(y_1+y_3)$, y_3, $\frac{1}{2}(y_3+y_5)$, y_5, $2y_6-\frac{1}{2}(y_5+y_7)$, y_7, etc.

Taking six spaces $\int_0^1 ydx=\frac{1}{3}(y_2+y_6)+\frac{1}{6}(y_3+y_5)$.

When applied to the areas mentioned by M. Fréchet in his letter in NATURE of May 17, the rule gives the following errors for $\int_0^1 ydx$:

y, $\sqrt{x-x^2}$, $\sqrt{1-x^2}$, $\sqrt{4x-x^2}$, $\log(1+x)$, e^x, $1/1+x$,
0·0028, 0·0041, 0·012, 0·0003, 0·0002, 0·0004,
$2/1+x$, $\sin x$, $y1/1+25x^2$.
0·0000, 0·012, 0·012.

These results are obtained by using four ordinates, and they compare well with those calculated by Simpson's rule using seven ordinates, but the advantage of this rule is still greater when more ordinates are used.

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Chemical Research in India.[1]

By Prof. JOCELYN F. THORPE, F.R.S.

THE Indian Industrial Commission, presided over by Sir Thomas Holland, issued its report in 1918. It had been formed in 1916, and was "instructed to examine and report upon the possibilities of further industrial development in India, and to submit its recommendations" with special reference to a number of specific questions, of which two only concern us here. These were "(*b*) to ascertain whether and if so in what manner, Government can usefully give direct encouragement to industrial development—

(i.) By rendering technical advice more freely available:

(ii.) By the demonstration of the practical possibility on the commercial scale of particular industries.

The Commission made a number of recommendations dealing with the various items of its remit. It recommended, for example, the formation of several scientific services built up on lines which, it was hoped, would give an impetus to the development of industries based on the great natural resources of the country.

Among the services the formation of which was recommended was one dealing with chemistry, and, as this subject was rightly regarded as one of the foundations of all industrial development, the first effect given to the report of the Commission was to appoint a committee with instructions to "formulate proposals for the organisation of a Chemical Service for India and for the location and equipment of research laboratories." I was asked to act as chairman of this committee, and with the object of obtaining an insight into the actual conditions, I toured through India during November and December of 1919 and January and February of 1920. In the course of the tour I visited all the important centres and was able to discuss the problems involved with many prominent officials and business men. I saw all the leading educational institutions and noted the facilities for research present in the chemical departments attached to them.

My conclusion was that India is at present poorly equipped to meet any demand for properly trained chemists, and cannot be expected to supply recruits for a chemical service unless the service itself can act as the research trainer. Nevertheless, the picture is not entirely dark, as it is possible that the Indian Institute of Science at Bangalore may, under the new regime, revert to its original purpose—the encouragement of post-graduate research in pure physical science—and become the centre of research training in India.

The scheme suggested by the Industrial Commission was a comprehensive one, and well fitted to meet the immediate industrial requirements of the country. It provided for the establishment of a central Government research institute at which both fundamental and practical research would be carried out, to serve as a nucleus from which chemists could be drawn to fill the various chemical posts throughout the Empire.

It was evident to me during the course of my tour, however, that the provinces would have nothing to do with such a scheme. Each and all of them were keenly alive to the needs of the times. They recognised the necessity for scientific investigation into the conditions underlying their existing industries, and were fully aware that many of their natural resources remained undeveloped and could only be developed through the agency of scientific research, but they wished to do these things on their own behalf, unhampered by any restrictions which might be exercised by a central Government institution such as that suggested by the Industrial Commission.

Still, a modified scheme by which each province would have its own research institute seemed practicable and, indeed, even an improvement on the original idea, provided that each provincial institute undertook to confine its activities, both fundamental and practical, to its own local immediate industrial needs, leaving a central institute under the Government to carry out those fundamental researches which underlay the industries of the country as a whole. A modified and extended scheme of this kind was recommended in the report of my Committee. In practice the provincial institutes would carry out research work on questions submitted to them by manufacturers in the province, and would also carry out research work on new industries, likely, owing to the presence of the raw material in the province or for other reasons, to be effectively established there.

In England, two very strong and reasonable objections would be at once raised to such a scheme. The first would be that the proposed organisation would take away the livelihood of a number of useful consulting chemists, the second that it would provide the manufacturer with an excuse for not doing what, in his own interests, he ought to do, namely, to establish and maintain a research laboratory of his own. But England is not India, and conditions which are present in the one country are absent in the other. There are very few consulting chemists in India, most of the consulting advisory work, where such exists, being carried out in the Universities. The second objection also would not apply to Indian conditions. Indeed, the successful working of the proposed organisation would, in all probability, lead to an effect precisely opposite in character. The chemist or chemists who had solved problems in the research institute submitted by a manufacturer would be loaned to the manufacturer for a sufficient period of time to enable him to place the new process on a working basis in the factory. The general effect would thus be to establish a research laboratory in the factory or to augment it if one already existed.

In the central Government institute, organised research of a fundamental character would be carried out. Much of this would arise during the operations conducted at the provincial institutes and would be referred by them to the central research institute; such reference would, however, only be made when the problem was either of general interest to the whole Empire, or, while fundamental in character, did not

[1] From a paper read before the Royal Society of Arts (Indian Section), on Friday, May 2.

give promise of sufficiently early practical results to warrant the provincial institute in attacking it. The decision on this point would rest with the provincial institute. It would be one of the chief duties of the central Government institute to survey the industrial possibilities of the Empire generally, and to initiate research having for its object the establishment of new industries in different parts of the country.

It will be seen, therefore, that the scheme suggested provided for the establishment of two very similar types of institution. One type, situated in each of the most suitable provincial centres, would be essentially practical in outlook. The other, situated at some convenient central place—the recommendation of Dehra Dun for this purpose by the Industrial Commission was endorsed by my Committee—would conduct research mainly fundamental in character, but would, nevertheless, deal in certain cases with investigations involving the practical establishment of a new industry.

One of the main advantages of this arrangement would be that the personnel could, to a certain extent, be interchangeable, a most desirable feature when it is remembered that each institution must necessarily act as a training centre for the personnel it employs. No university or technological system of training can be expected to discriminate between the men who are best fitted to act as leaders of research and those who are suited by natural characteristics and temperament to be leaders in the conduct of works practice. It is essential, where chemical manufacturers are concerned, that each type of man should have received the same grounding, and this is adequately effected by a system involving a course of instruction up to the honours graduation stage, followed by a training in research methods, the latter serving to impart the feeling of self-reliance and patience essential to success in a chemical worker, which cannot be obtained otherwise.

It is the final problem, that is, how to supply the training in works practice, and what is still more important, how to pick out the men most suited by temperament to profit by this training, which has to be solved not only in India but in Great Britain also. In the proposed chemical service this very real problem of type would be met by a frequent interchange between the individuals comprising the junior personnel of the research staffs of the various institutes. Each man would, therefore, obtain his training in works practice, and I am convinced that such training would serve as a method by which the men could be separated into two distinct classes, namely, those having a practical bias, and those whose instincts led them to take up work of a more fundamental character in the laboratory.

Each provincial institute, as well as the central Government institute, would, therefore, be provided with a main general research laboratory equipped in the usual manner, a semi-large scale laboratory provided with small scale plant suitable for making material on, say, the 10 lb. scale, and another laboratory where the " unit " scale plant could be erected. It is probable that the two latter types could be combined into one laboratory. All that is required is an open floor space on which plant can be built up and pulled to pieces at will; it would have to be provided with the usual services of gas, water, etc. These proposals imply that, besides the main chemical staff, each institute would have to be provided with a suitable staff of engineers, whose main duty would be to act as instructors in general engineering practice.

The proposed scheme for the establishment of a chemical service would have to start in a small way, and, no doubt, in many of the provinces use could be made of some existing institute to act as the provincial research institute, until funds were available for the erection and equipment of a building especially designed for the purpose. The chief initial cost would be incurred by the erection and equipment of the new Government Research Institute at Dehra Dun, but it is understood that some of the money, at any rate, has been allotted for this purpose. Indeed, it is likely that a large capital expenditure and a considerable income would be necessary in order to start the scheme and to place it initially on a sure financial basis, because it is not proposed that any attempt should be made to make the service self-supporting, and the equipment of the new laboratories would have to be completely up-to-date. If the Service is to succeed, the Government must take the long view, and bear in mind, chiefly, the increase in wealth to be obtained by the development of the natural resources of the country. The opportunity is a splendid one, but to take advantage of it effectively requires courage and vision.

Problems of Muscular Receptivity.[1]

By Sir CHARLES SHERRINGTON, O.M., G.B.E., P.R.S.

LET us revert now to the reflex " standing " exhibited by the decerebrate animal. We traced it to a postural contraction of the antigravity muscles, in each of which the contraction was due to a proprioceptive reflex excited somehow in that muscle itself. We can take as an example of the antigravity muscles the knee-extensor muscle. The tendon of that muscle bridges the extensor aspect of the knee-joint, and the superincumbent weight of the body in the erect posture tends to flex the knee. Knee-flexion stretches the extensor muscle. Gravity in the erect posture acts therefore on the knee extensor as a stretching force. We have seen that such a stretch is a stimulus to certain receptors in the muscle and provokes a postural contraction which counteracts the stretching force. The reflex standing of the decerebrate animal appears therefore as a postural stretch-reflex.

A peculiarity which distinguishes the stretch-reflex from other reflexes is that, whereas in other reflexes the reflex contraction excited from a single source implicates whole groups of the limb muscles, the stretch-reflex excites in its limb just the one muscle stretched. The reflex standing of the limb is a harmonious *congeries* of stretch-reflexes, each component reflex being the self-operating reaction of an individual extensor muscle.

[1] Continued from p. 894.

This mode of production of the reflex posture allows it latitude in detail. The standing pose is still maintained though the observer shift in detail, within limits, the position of the feet. Thus a foot may be advanced or set backward, and the shift alters the position in detail, but the reflex animal still stands. The altered incidence of gravity involved by the shift compensates itself, and greater and lesser stretch wherever they occur excite, as we have seen, a correspondingly greater or lesser contraction which antagonises further yield and compensates the altered stretch.

The living reaction of plants and animals to gravity is called geotropism, and standing is a geotropic reaction. The stretch-reflex of the extensor muscles offers an explanation of how the limbs can antagonise gravity and stand, but that reflex provides no mechanism by which the reflex animal can, when non-erect, assume the erect posture; for that, as Magnus and de Kleyn have shown in a fascinating series of experiments, other reflexes provide, reflexes initiated by special gravity receptors in the head, the otolith organs. It is interesting to note that a group of stretch-reflexes operated by gravity should dovetail in with special gravity reflexes from the head, giving gravity still further reflex control of the whole animal's posture as regards standing. In instance of this further control there is the reflex discovered and elucidated by Magnus and de Kleyn in which, the reflex animal's initial posture being standing, a passive tilt of the head upward, thus inclining the head's gravity organs, changes the reflex posture from that of standing to that of sitting and looking up at a shelf. The hind-limbs flex and sink, the fore-limbs straighten more, bearing upward the inclined neck and head. Conversely, a passive downward tilting of the head causes, Magnus and de Kleyn have shown, the fore-limbs to crouch, bringing the forequarters lower than the hind, thus modifying the standing position to that for taking food from a platter. Accepting the stretch-reflex of the limb-extensors as existent in this reflex standing, the otolith organs, reacting in postures of the head, evidently suitably control that limb-reflex, depressing or reinforcing it as circumstances dictate. The stretch-reflex of the limb-extensors is, however, a reaction essentially independent of the otolith organs, although it can be regulated by the otolith organs; it still obtains (Liddell and Sherrington) after bilateral severance of receptive nerves of the latter.

Elicitation by gravity of the stretch-reflex of the limb-extensor suggests itself as a basic factor in this static geotropic reflex of standing. As such it offers an explanation of the postural contraction counteracting gravity, of the proprioceptive nature of that reaction, and of the latitude of detail allowed to the standing posture of the reflex limb. As to accepting without reserve this scope for the stretch-reflex, certain experimental facts enjoin caution. When, in obtaining the reflex preparation, the portion of brain removed encroaches backward, *i.e.* is larger, the standing of the limb is exaggerated in degree; whereas when the decerebration is more restricted, *i.e.* more of the brainstem remains, the creature, though purely reflex, exhibits (Magnus and de Kleyn) a standing in which the postural contraction is practically normal in degree. In the former type, assuming for it the stretch-reflex, that reflex is giving an exaggerated caricature of standing rather than truly normal standing. This may however merely mean that for full normality of reflex standing several reflex factors, involving successive brain levels, co-operate, among them being the stretch-reflex of the limb-extensors, and that this reflex occurs in exaggerated form when "released" by removal of co-ordinate centres further forward. Such would have analogy with the "release" exaggeration of the reflex postural extension of the fore-limbs, which regularly ensues when the post-brachial spinal cord is severed. There the "release" seems due to severance of an inhibitory path studied in cerebellar (vermis) cortex by Banting and Miller, by Camis, and by Bremer; and by Bremer traced from spino-cerebellar afferents, through cerebellum and mesencephalon, and thence back to reach spinal centres of the limb-extensors.

A more obstinate ground of difficulty appears in the experimental fact that the reflex creature, decerebrate through posterior colliculi and with otolith organs out of action by nerve-severance, retains a postural contraction of its limb-extensors when the line of gravity runs not lengthwise in the limb.

In reflex standing we met the stretch-reflex in its postural form. But, as we saw, it can also operate movements. Now locomotion, whether of walking or running, is a rhythmic movement of the limb grafted upon the erect attitude of the body. Just as the erect posture can be maintained by pure inconscient action of the nervous system, so likewise can the stepping of the limbs. In this inconscient stepping the contact of the foot with the ground might be thought to supply an important skin-stimulus reflexly evoking the step. But the receptivity of the skin seems not to actuate reflex stepping any more than it does reflex standing. Indeed, from the observations of Prof. Graham Brown, an intrinsic automatic activity of the spinal centres seems the essential nervous mechanism responsible for inconscient stepping, a central activity comparable with that of the respiratory centre in the bulb, and like this latter highly regulable by reflex action.

The motion of a limb in the step is broadly divisible into two phases—a flexion phase in which the hip, knee, and ankle are flexed, carrying the foot forward clear of the ground, and an extension phase in which the hip, knee, and ankle are extended, bringing the foot to the ground and pushing the body forward from the ground as point of support. In the flexion phase the bending of the knee by the flexor muscles stretches of course the extensor muscle of the knee. But at that time, judging by analogy from the well-known "flexion reflex," the proprioceptive arc of the extensor muscle lies under inhibition, a reciprocal inhibition, one of the main purposes of which may indeed be to preclude a potential stretch-reflex from impeding the active flexion. At completion of the flexion phase the lapse of its concomitant inhibition of the nervous arc of the extensor muscles must leave the stretch-reflex free. The step, in fact, repeats, though probably less abruptly, the experiment in which the stretch-reflex wakes to post-inhibitory freedom. The precurrent flexor phase thus, so to say, compresses the spring which, when released, does the main work of the step. The extension phase itself in its turn, during the course of its performance, by straightening the knee, effects relief of the stretch of the extensors, and so terminates itself by abrogating its own promoting stimulus.

Further contribution by the stretch-reflex to the extension phase of the step occurs also in another way. When the extensor muscle is actively contracting, a stretch applied to it enhances immediately and greatly its contraction. The myograph record (Fig. 3) exemplifies this from an experiment meeting the requisite conditions. A passive stretch, amounting to but 2·5 per cent. of the length of the active muscle, causes the contraction-tension of the muscle to become

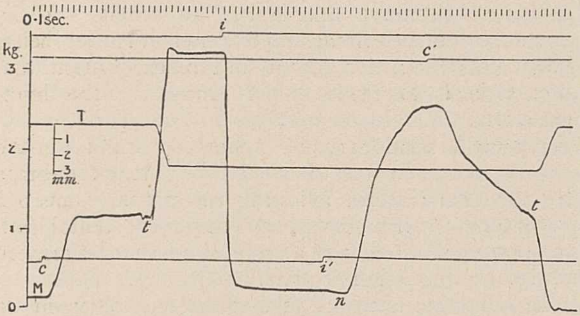

FIG. 3.—Vasto-crureus. From C to C′ stimulation of contralateral afferent peroneopopliteal nerve (break-shocks at 40 per sec., coreless primary fed by 0·2 amp., secondary coil 16·3 cm. from primary) evoking reflex contraction. At *t* a 2·5 mm. stretch; at *t′* relief of the residual stretched-posture. From *i* to *i′* stimulation of inhibitory afferent nerve; this nerve as frequently evoked, besides inhibition of the contralateral nerve's reflex contraction, slight reflex contraction on its own part, so that full inhibition revealing the passive tension component in the reaction to this stretch is fully evident only at *n*, where on cessation of the ipsilateral stimulus the slight ipsilateral contraction passed off though the inhibition temporarily remained. Myograph multiplying tendon-movement 62 times. Time in 0·1 sec. (Liddell and Sherrington.)

three times as great. Now, a part of the knee-extensor muscle, the "double-joint" portion, bridges across the hip as well as the knee. It lies across the flexor aspect of the former. In the extension phase of the step the angle of the hip, like that of the knee, opens. This opening of the angle of the hip necessarily stretches the part of the knee-extensor bridged across it. Thus a stretch is given to this part of the extensor not by its antagonists, but by its own ally-muscles, the extensors of the hip. This, happening as it does during the extension phase, occurs when the extensor muscle is already in action and obviously not under inhibition. This stretch must therefore, as our experiment shows, enhance further the reflex contraction already in operation, and do so at the period of mid-progress of the extension phase when the foot is in contact with the ground and the weight of the body bears most on it, because acting approximately vertically above. Later, with fuller straightening of the knee towards the end of the extension phase, this stretch upon the double-joint portion of the muscles diminishes and lapses, and with it the enhancement of contraction. The stretch-reflex thus in two respects plays an important part in the extension phase of the action of the step.

Study of the stretch-reflex in its greater completeness and entirety has been but recent. There can, however, be little doubt that the "knee-jerk," a reaction long familiar to the physician, is a fractional manifestation of it. The "knee-jerk" is a slight twitch-like contraction of the muscle of the front of the thigh. The physician evokes it by a light tap directed close below the knee-cap. This stretches the thigh muscle slightly, and evokes from the muscle a slight contraction lasting some tenth of a second. The routine of the physician employs this brief reaction as a test where there is question of certain diseases of the nervous system. Where there is, as in tabes dorsalis, degeneration of the receptive nerves of muscle, absence or impairment of the knee-jerk is apt to be an early symptom. Of common occurrence in tabes dorsalis, along with impairment of the knee-jerk, are two other symptoms, namely, defect of the normal ability to walk or run, and impairment of normal ability to stand, especially with the eyes closed. The physician in testing the knee-jerk is in fact testing the stretch-reflex of an antigravity muscle. We have seen the rôle which that stretch-reflex plays in the performance of the step and in the maintenance of standing. In the light of that we can appreciate more clearly the bearing of the little evanescent twitch, the "knee-jerk," on the two fundamental acts, motor and postural, of stepping and of standing. That bearing emphasises the contribution made to the inconscient reflex performance of these acts by the receptivity of the muscles which they employ.

We have thus glimpsed something of the contribution made to bodily posturing and movement by reflex action arising in the muscular receptors. These same receptors connect also with the mental region of the brain. What kind of mental experience do they enable? I do but mention this in order that, regarding muscular receptivity, there shall not escape us the similarity which exists between its reflex and its sensual scope. This latter concerns the perception of our postures and our movements, their intensity, their direction, speed, and extent. In their sensual aspect the muscular receptors serve as means whence mental experience can work toward attainment of yet finer delicacy and precision for the muscular acts of the body, and arrive even at trains and combinations of them that, in so far, are acquisitions altogether new. The two reactional aspects, the sensual and the purely reflex, of muscular receptivity reveal therefore two sides of, broadly taken, one singly-purposed function addressed to a single problem, in brief, the taxis of execution, the management—from rough adjustment onward into minutely refined *finesse*—of the acts of our skeletal muscles, which is to say, in the language of the older physiologists, the movements and postures of our life of external relation.

Though the general problem is thus broadly definable, its content of unanswered questions is legion. Passive stretch applied to the extensor muscle provokes reflex contraction in it. The stretch stimulates receptors which through the receptive nerve of the muscle provoke contraction. The nerve of the muscle consists of several branches. Take one of these branches, cut it across, and stimulate its central end, the end connected with the nerve-centres. The receptive nerve is thus stimulated not, it is true, through the medium of stretch applied to its receptors, but directly. Yet no contraction of the muscle results. We should not, of course, expect contraction in that part of the muscle, the nerve-branch of which has been cut, because from that part we have, by cutting the branch, withdrawn the motor nerve-supply. But from the rest of the muscle with motor supply intact, we might expect reflex contraction. Not only is there none, but further, the muscle, if reflexly contracting at the time, is thrown out of contraction. Instead of reflex contraction, there is therefore reflex inhibition. Evidently the muscle is provided with more than one kind of receptor; it possesses certainly two kinds with diametrically opposed functional effect. Like the heart, it has two opposed nerves, one of augmentor function, one of inhibitory function—only in the case of our skeletal muscle these two opposed nerves are afferent and not efferent.

The significance of this is at present obscure. The "lengthening reaction," it is true, may involve a reflex inhibition and is certainly proprioceptive. We must also not forget that muscles can give rise to pain. Cramp, rheumatism, muscular fibrositis, and neuritis evidence this only too commonly. Even a small partial rupture of a muscle makes it a seat of pain when it contracts. In all such cases the treatment that the physician's experience enjoins is rest; that is the treatment that Nature herself seems to aim at, for she enforces it, in the last resort prescribing pain, if rest be departed from. Existence of these inhibitory afferents from muscle suggests she enjoins involuntary desistence from contraction by reflex inhibition. Some involuntary, as well as voluntary, restraint from use of his lumbar muscles restricts the lumbago patient in rising from his chair. But the problem of the proprioceptive nerve, which inhibits its own muscles, certainly cannot be satisfied wholly in this way. Among such proprioceptives are some which, while reflexly inhibiting their own muscle, excite contraction of the antagonist, thus causing for their own muscles a stretch scarcely likely to be soothing to inflammation. Moreover, there are muscles which seem not to possess proprioceptors inhibitory of themselves.

The microscope likewise separates the receptors of muscle into species of more than one kind, well-differentiated forms, muscle-spindles, Golgi tendon-organs, basket-endings, tendril-terminals, Pacinian corpuscles, and so on. It is unlikely that for all these the adequate stimulus can be the same, or the functions identical. In perception of postures and movements there seem traceable, as underlying data, degrees of muscle-length on one hand and, on the other, degrees of muscle-tension. Some muscle-receptors may be length-recorders, others tension-recorders; one would suppose the Golgi tendon-organs among these latter. As to the "muscle-spindles," the muscle fibres they enfold, though differing within the spindle from those outside, yet receive motor-terminals; one would suppose active contraction to supply their stimulus. Through them and through other receptive endings which clasp muscular fibres, the active contraction of the muscle might be expected to evoke reflex reactions, and to furnish a "contraction" datum for perception of active postures and movements.

At present, however, there seems little evidence that active contraction *per se* excites receptors in the muscle itself. Using that delicate index, the electric action-current of the nerve, and in the uncut nerve of the muscle, Forbes and Gregg and Forbes and Adrian have shown that the action-current in a reflex excited by a single shock is practically as brief lasting as in the direct reaction of the cut motor-nerve itself. No proprioceptive reverberation seems to ensue. Again, Cooper and Adrian, with the action-currents of the muscle in reflex tetanus, find secondary waves following the primary ones of the response. In view of the likelihood that these secondary waves might be a proprioceptive repercussion set up by the primary contractions, they paralysed these receptors, but only to find the secondary waves still persist. Germane to the general negative result with reflexes seems that unexpected feature of the "muscular-sense," revealed by perceptual examination of movements and postures, namely, that the fineness and accuracy of our perception of these when they are passively performed, *e.g.* by external means applied to a limb itself passive and inactive, is practically no less delicate than when they are performed by muscles themselves actively contracting. This would seem to suggest that the receptors of muscles are functionally merely on the same plane as are the receptors of the joints.

Muscular receptivity offers a wide field, and our view of it has perforce been but a glimpse. That glimpse, however, may have served to show that through their own nervous arcs the muscles have a voice in their own management and co-ordination, and they are, moreover, not motor machines only but sense-organs as well. Only by fuller study of them in these aspects can we know how best to use them. Should this short account serve to attract recruits to that study, it will have been of good augury for progress in the problems of muscular receptivity.

Obituary.

DR. R. M. WALMSLEY.

WE regret to announce that Dr. Robert Mullineux Walmsley died on June 15, after a street accident which happened two days previously when he was knocked down by a motor vehicle immediately after getting out of a tram-car. Every attention was given to him at the hospital, but he never regained consciousness.

As Principal of the Northampton Polytechnic Institute in Clerkenwell, Dr. Walmsley was very well known in connexion with engineering training. In 1901 he started day courses in that college in electrical and mechanical engineering. In 1903 the governing body sent him to the United States and Canada to study the methods adopted in engineering training. The results he deduced from this tour were communicated to the Institution of Electrical Engineers in a lengthy paper read in February 1904. This paper gave rise to considerable discussion. He was of opinion that employers in Great Britain should be educated to the advantages of taking technically trained men. The system which he adopted at the Northampton Institute was a modified "sandwich" course, unsuitable men being gradually weeded out by examination.

Dr. Walmsley was born near Liverpool seventy years ago, and was connected with technical education practically all his life. He matriculated at the University of London in 1879, obtaining the degrees of B.Sc. and D.Sc. in 1882 and 1886 respectively. He was appointed senior demonstrator in electrical engineering at the Finsbury Technical College in 1883. He went to India in 1887 as Principal of the Sind Arts College of the University of Bombay. Returning to England a year later, he became the first professor of electrical engineering and applied physics at the Heriot-Watt College, Edinburgh. In 1896 he was appointed Principal of Northampton Institute, a post which he held until his death.

Dr. Walmsley was chairman of Convocation and a senator of the University of London, and for many years he played a prominent part on many committees. He was for fifteen years chairman of the University Extension Board. In 1909 he was chairman of the council of the Association of Technical Institutions, and in 1912 he was chairman of the Optical Convention. He had also served on the council of the Royal Aeronautical Society, and was a member of the Institution of Electrical Engineers and a fellow of the Institute of Physics and of the Physical Society. He re-wrote and greatly extended Dr. Urbanitzky's "Electricity in the Service of Man," and was the author of other educational works.

MR. F. MERRIFIELD.

BY the death at Brighton on May 28 of Frederic Merrifield, at the venerable age of ninety-three years, British entomology loses one of its best known and most highly esteemed representatives. Mr. Merrifield was the son of a barrister of the Middle Temple, and was himself called to the Bar so long ago as November 1853. His mother, Mary Philadelphia Merrifield, was a lady of high scientific attainments, who quite late in life acquired a knowledge of the Norwegian language in order to correspond with Prof. Agardh on the subject of Algae, on which she was a recognised authority. Up to her death in 1888 at an advanced age, she was a frequent contributor to NATURE, and there can be no doubt that her son derived from her that wide interest and devotion to natural science which marked the whole of his long life.

In the intervals of leisure afforded by a strenuous public career at Brighton, where for many years he was Clerk of the Peace, besides serving on the County Councils of East and West Sussex, Mr. Merrifield became proficient in more than one branch of natural history. The study of the Order Lepidoptera, however, chiefly engaged his attention, and his masterly series of researches on the effects of various conditions of temperature in the early stages of certain butterflies and moths, on the resulting perfect insects, are familiar to all entomologists. These experiments were carried out between the years 1887 and 1896, and were in the first instance undertaken on behalf of the late Francis Galton in order to obtain data for the revision and extension of a general theory of simple heredity. The memoirs on these researches appeared in the Transactions of the Entomological Society of London, and are of high interest, especially with reference to experiments of a similar nature conducted independently by Standfuss, Weismann, and other investigators. An excellent detailed summary of these papers, by Dr. F. A. Dixey, was given in NATURE, Vol. 57, of December 23, 1897, pp. 184-188.

Mr. Merrifield, who was elected a fellow of the Entomological Society in 1887, served as one of the secretaries in 1887 and 1898, and occupied the presidential chair of the Society with distinction in 1905-6. His genial address and kindly nature endeared him to all, and although an invalid for a good many of his later years, his mental powers and his keen appreciation of the beauties of Nature remained unabated to the very close of his long life. The collections of Lepidoptera which embody the results of his experiments will find a permanent and appropriate resting-place in the Oxford University Museum.

J. J. W.

CAPT. W. F. CABORNE.

THE sudden death of Capt. Warren Frederick Caborne occurred from acute peritonitis on June 14 at Loppington Hall, near Wem, Shropshire. He was nearly seventy-five years of age, being born in July 1849. At the age of sixteen Caborne joined the mercantile marine and served for some time under Capt. Henry Toynbee, who was the first marine superintendent in the Meteorological Office. He joined the R.N.R. in 1879, and became a lieutenant in 1882. He was in command of the transport *Adowa* during the Burma Expedition. Caborne retired from the R.N.R. in 1894 with the rank of Commander; he was a Nautical Assessor from 1898 until 1914, and served in the same capacity to the Court of Appeal from 1903 to 1908, and to the Privy Council. He was a fellow of the Royal Geographical Society, the Royal Astronomical Society, and of the Royal Meteorological Society. For many years he served on the council of the latter; he was also a vice-president, and for some time honorary secretary. He was the author of numerous papers dealing with the naval reserve and marine subjects.

In later years Caborne was a member of the council of the Royal United Service Institution, and he also gave active support to the Smoke Abatement Society. Offering his service to the Government during the War, he was employed under the Director of Naval Ordnance, and for his service was promoted to Captain on the R.N.R. retired list in 1918.

WE regret to announce the following deaths:

Dr. W. J. Beal, for forty years professor of botany in the Michigan Agricultural College, on May 12, aged ninety-one.

Sir James J. Dobbie, lately Government Chemist and formerly Director of the Royal Scottish Museum, Edinburgh, aged seventy-one.

Dr. R. H. Jude, for many years head of the Mathematical and Physical Departments of Rutherford College, Newcastle-on-Tyne, on June 1, aged seventy-one.

Prof. J. G. Longbottom, professor of mechanics in the Royal Technical College, Glasgow, aged fifty-four.

Charles Oberthür, naturalist and printer of Rennes, aged seventy-eight.

Mr. E. P. Rathbone, a foundation member and member of council of the Institution of Mining and Metallurgy, on June 14, aged sixty-seven.

Sir Adolphus William Ward, Master of Peterhouse, Cambridge, and Vice-Chancellor of the University of Cambridge 1901–2, on June 19, aged eighty-six.

Current Topics and Events.

OF the numerous Botanic Gardens that have been established throughout the Crown Colonies during the past century, the only ones now remaining as an independent department are those of the Straits Settlements at Singapore and Penang. Under Mr. H. N. Ridley, the scientific reputation of this Department attained a high level, which has been well maintained by the present Director, Mr. I. H. Burkill. With the development of the Malay Peninsula, however, the scientific centre of the country has passed of recent years to Kuala Lumpur, and the more recently constituted Departments of Forestry and Agriculture are both centred there. It is natural, therefore, that the Botanical Department, which works with each, should also incline to Kuala Lumpur, and in this connexion it is rumoured that a possible change in the centre of botanical activities may be considered. The continued economic approachment of the Federated Malay States and Straits Settlements is a natural process, and it is only reasonable that each should contribute to the maintenance of a department which serves both and at present is maintained by the Straits Government only. The recent alienation of the Economic Section of the Singapore Gardens for building purposes materially limits the scope of the work which can be carried out from Singapore, and suggests that some alteration is desirable if the botanical work of the country is to be continued and be given full opportunity to develop. Mr. Burkill is due to retire in February 1925, and should the headquarters of the Department be moved to Kuala Lumpur and a new garden established there, from which those at Singapore and Penang would be administered, the selection of a successor is of more than usual importance. It will be no easy task to secure a Director capable of maintaining the traditions of the past and of reorganising and administering the Department in a widely extended sphere.

WHEN the Optical Convention was held in London in 1912, sextants, theodolites, telescopes, and binoculars were tested at Kew, and it was only in the succeeding year that the work was transferred to the National Physical Laboratory. The transfer of the tests and their improvement occupied so large a proportion of the time of the staff of the Optics Department that little progress could be made with the study of aberrations of optical systems which they had commenced, and their contributions to the volumes of Collected Researches of the Laboratory for 1912, 1913, and 1914 were small. In these circumstances, progress in optical industry could only be slow, but the industry seemed quite content with the pace until the War showed that important branches of the trade were practically controlled by German manufacturers. The Minister of Munitions appealed to patriotic citizens in 1916, and as a result the School of Technical Optics at the Imperial College, South Kensington, was founded. The issue of the Collected Researches of the National Physical Laboratory for 1922 shows how important for optics the intervening years have been. Although the volume covers more than 350 pages its 31 papers are on optics only, and represent to a large extent the work of three men not entirely free from routine duties. Of its great ultimate value for the industry there can be no doubt, but it rests with the industry to see that the advances made in the laboratory are translated without delay into improvements of the instruments manufactured. This can be effected only if we are training sufficient scientific workers who can appreciate advances even when embodied in mathematical formulæ and these men are being absorbed by the industry. It must no longer be true of optics that " accurate writing is unintelligible to the reader," the intellectual chain from research to manual worker must be unbroken.

SCIENTIFIC readers everywhere will read with regret the brief telegram dated June 19, which has appeared in the *Times*, announcing the deaths of two members of the Mount Everest Expedition, Mr. G. L. Mallory and Mr. A. C. Irvine. At the time of writing, no detailed information is available beyond the fact that the unfortunate accident occurred on the occasion of the third and final attempt which was to have been made to reach the summit early this month. On two previous attempts, the climbers were defeated by the unusually severe weather conditions, and it seems probable that bad weather was the cause of the disaster. Mr. Mallory, who was an experienced climber, was the only member of this year's party who had taken part in the two previous expeditions: his death at the early age of thirty-nine is a great loss to mountaineering. Mr. Irvine, who was only twenty-two, joined the Mount Everest Expedition straight from Oxford. He had had some experience of ice-work with the Merton College Expedition to Spitsbergen last year, and owed his selection for the Mount Everest Expedition mainly to his physique. Thus has closed in tragic fashion another chapter in the story of the attempts to scale Mount Everest.

SIR J. J. THOMSON gives an interesting appreciation of Lord Kelvin in *John o' London's Weekly* for June 21, laying stress on the fact that the development of the Second Law of Thermodynamics formed the basis for much of Kelvin's most important scientific work. As a young man, Kelvin had the good fortune to work for a short time in Regnault's laboratory in Paris, and this experience under one who was a master of the art of accurate measurement was of great value to him. The importance of the work he did in submarine telegraphy and in navigation is also emphasised. For more than sixty years Kelvin was a leader, and for the greater part of this time the most conspicuous figure, in physical science and its applications. He made the meetings of the British Association go with a swing from start to finish, stimulating and encouraging as no one else did the younger men who crowded to hear him. His personality was as remarkable as his scientific achievements. His genius and enthusiasm dominated any scientific discussion. Never had science a more enthusiastic, stimulating, or indefatigable leader.

Sir J. J. Thomson reminds us that at the British Association meetings in the later years, Kelvin was generally accompanied by Lady Kelvin, who would often stay with him to the end of the meeting.

A COMMENCEMENT has been made with the publication of scientific papers from Jerusalem, the two so far received being " Beweis der Nichtexistenz eines überall regulären zentrisch symmetrischen Feldes nach der Feld-Theorie von Kaluza " by Einstein and Grommer, and " Fluid Motion past Circular Barriers " by S. Brodetsky. While these two papers themselves are not necessarily of prime importance, this new venture may well mark the beginning of a definite shift in the centre of gravity of scientific publication. Such well-known continental names as Einstein, Levi-Civita, Landau, Loria, Born, Hadamard, Karman, to take a few at random, and a host of others, need merely be mentioned for it to be evident that if these investigators were to publish their work exclusively from Jerusalem, the contribution of Jewish workers to scientific knowledge would be clearly distinguishable. Whether or not it would correspond to anything distinctively Jewish is a different matter. As things are at present, it is well-nigh impossible to trace any common Jewish characteristic throughout the work of these men, and it is unlikely that mere publication, and nothing more, from Jerusalem will achieve this. A distinctively Jewish school in science is likely to be obtained only by a group of Jewish scientific workers investigating from a common geographical area and developing from a distinctive educational scheme. This Palestine has not yet achieved, but the large number of Jewish scientific workers of first rank arising from a scattered population of about thirteen millions indicates that the intellectual potentialities of the race are not inconsiderable. The present publications are bilingual, Hebrew and the language in which the papers were originally written, but it is probable that this is merely an intermediate phase. A scientific school of thought in Jerusalem, one would expect, would publish in Hebrew. Does this mean that scientific workers are presently to be faced with the necessity for acquiring yet another language ?

A REPORT has recently been issued of the work carried out during the last year by the Joint Board of Research for Mental Disease, established by the City and University of Birmingham. The lines of research have been initiated by Sir Frederick Mott, the honorary director of the laboratory, and Dr. T. C. Graves. A respiratory chamber similar to that used in the University of Birmingham Mines Department has been constructed for the purpose of investigating basal metabolism in mental disorders. Mr. D. L. Woodhouse is conducting a research into the pathology of mental disease by an investigation of the effects of hypnotics upon animals, more especially in relation to growth and metabolism. The routine work of the laboratory, which is carried out under the direction of Dr. Pickworth, includes all the usual pathological and bacteriological investigations for the Birmingham Mental Hospitals, and an extensive bacteriological examination is being made to ascertain the connexion between mental disease and chronic septic infection. On the clinical side the same line is being pursued, with the aid of the dental, gynæcological, and other special departments recently established by the Asylums Committee. The utility of tryparsamide and bismoxyl, the latest drugs used in the treatment of dementia paralytica, is also being investigated.

AT the recent meeting of the Association to aid Scientific Research by Women, the Research Prize of 1000 dollars was awarded to Dr. Mary Evelyn Laing, of the University of Bristol. Ten theses were considered, seven of these being from Great Britain and three from the United States. With this award going to one of the competitors in Great Britain, the two countries are even in the awards, each having had three successful candidates, and each country having had the grant of 1000 dollars once. Dr. Laing submitted her thesis under the pseudonym of " Venture," and it proved a good venture. The title of the thesis was " A General Formulation of Movement in an Electrical Field : Migration, Electrophoresis and Electro-osmosis of Sodium Oleate." Miss Laing received the B.Sc. degree from the University of Bristol in July 1915, the M.Sc. from the same University in 1919, and the D.Sc. in August 1923. She is the author of a number of scientific papers published in the Journal of the Chemical Society, dealing with soap solutions and the structure of jellies. Her latest work has led to a simple and unexpected general relation between the electrical behaviour of colloids and ordinary salts. Her paper is to appear in the *Journal of Physical Chemistry*. She at present holds the appointment of research assistant and lecturer in physical chemistry at the University of Bristol.

ON June 11, at the dinner of the Worshipful Company of Woolmen, a special gold medal was presented to Prof. J. Cossar Ewart, of the University of Edinburgh, " in recognition of work done for the benefit of the Wool industry." The obverse of the medal is a ram's head with horns surrounded by the words, " The Worshipful Company of Woolmen," and below the head-is a woolsack ; the reverse is inscribed, " Presented to Professor James Cossar Ewart, M.D., F.R.S., for research in connection with wool. 1924." The award was made by a committee appointed, at the request of the Company, by the council of the University of Leeds. Prof. Cossar Ewart is well known for his researches into the origins of the domestic sheep. He has also carried out many important breeding experiments on the University farm at Edinburgh, and has shown the value of the Southdown and Blackface from the wool point of view. For some time he has acted as chairman of the Sheep-breeding Conjoint Committee of the British Research Association for the Woollen and Worsted Industries and of the Board of Agriculture. Scientific work does not always receive the recognition from the practical men that it merits, and this honour, which we hope is only the first of many such, should prove stimulating to scientific workers.

THE forthcoming meeting of the French Association for the Advancement of Science will be held at Liège on July 28–August 2, under the presidency of M. P. Viala, of the National Agricultural Institute, Paris.

LT.-COL. ANDREW THOMAS GAGE, Director of the Botanical Survey of India and Superintendent since 1906 of the Royal Botanic Gardens, Calcutta, has been appointed Librarian and Assistant-Secretary to the Linnean Society of London.

AT the Cincinnati meeting of the American Association for the Advancement of Science, a prize of 1000 dollars was offered by a member of the Association for a paper contributed to the meeting constituting a notable contribution to science, and the prize was awarded to Prof. R. B. Dixon, of the University of Chicago, for his mathematical papers. We learn from *Science* that a similar prize has been offered by the same member, who still remains anonymous, for each year for a term of five years beginning with the Washington meeting in December next. There is to be no restriction as to the manner of award, but it is desired that the prize should not be given in two successive years in the same major division of science.

A CONFERENCE of Modern Churchmen, at which the subject for discussion will be " The Scientific Approach to Religion," will be held at Oxford on August 25–September 1. Dean Inge is to open the Conference, and other speakers include Prof. E. W. Macbride, on evolution ; Prof. J. G. Adami, on the possibility of purpose ; the Rev. H. Macpherson, on the universe as revealed by astronomy ; Mr. J. W. R. Calvert, on modern knowledge of the structure of matter ; Prof. J. S. Hadane, on biology and religion ; Prof. C. Lloyd Morgan, on the autonomy of life and mind ; and Mr. J. A. Hadfield, on psychology and religion. Canon E. W. Barnes will preach a sermon on Sunday, August 31, on faith and the future. Particulars of the meeting can be obtained from the hon. secretary, Miss Dora Nussey, Westfield, Ilkley.

THE thirty-fifth annual conference of the Museums Association will be held at the Conference Building of the British Empire Exhibition at Wembley on July 21-26, under the presidency of Dr. H. Bolton, Director of the Bristol Museum and Art Gallery. Papers have been promised on museum development, by Dr. H. Bolton ; on fossils as museum exhibits, by Dr. F. A. Bather ; on museums and ethnography, by Dr. H. S. Harrison ; on the policy and scope of the Science Museum, by Col. H. G. Lyons ; on industrial art, by Sir Cecil H. Smith ; and on the preservation of wild life, by Mr. C. W. Hobley. The arrangements include visits to the Victoria and Albert Museum, the British Museum (Natural History), and the Science Museum. The Conference of Delegates of Corresponding Societies of the British Association, which has been arranged in conjunction with the Museums Association, is to be held at Wembley during the afternoon of July 22, when Dr. J. L. Myres will read a paper on the preservation of sites.

A SCOTTISH Cattle Breeding Conference will be held in Edinburgh on July 7-12. It has been convened in order to enable cattle breeders from all English-speaking countries to meet recognised authorities in animal genetics and to discuss with them the notable contributions which science has, during recent years, made to the theory and practice of animal breeding. Among the papers of scientific interest and importance which will be presented at the Conference are the following : Dr. Raymond Pearl (Johns Hopkins University, Baltimore), " Some Unsolved Problems of Genetics in Relation to Cattle Breeding " ; Dr. L. J. Cole (Bureau of Animal Industry, Washington, U.S.A.), " Genetics of Cattle Inheritance ; Breeding by Type, Pedigree and Progeny Performance ; Inbreeding and Outbreeding " ; Mr. E. N. Wentworth (Armour's Livestock Bureau, Chicago), " Relation between Genetics and Practical Cattle Breeding ; Prepotence in Character Transmission ; Character Correlation in Cattle Breeding " ; Prof. J. Cossar Ewart (Edinburgh), " The Origin of Cattle ; Fallacies in Cattle Breeding " ; Prof. J. A. Scott Watson (Edinburgh), " Inheritance in Scottish Breeds ; Families and Line Breeding " ; Prof. James Wilson (Dublin), " The Formation of Breeds " ; Mr. J. MacIntosh (Reading), " Uniform System of Stating Milk and Butter-fat " ; Mr. John Hammond (Cambridge), " The Reproductive Function in the Cow " ; Dr. John W. Gowan (Maine), " Review of Cattle Breeding Experiments at Maine Agricultural Experiment Station." The organising secretary is Dr. G. F. Finlay, Animal Breeding Research Department, Edinburgh, with whom any one interested is invited to communicate. It is hoped that the Conference, by bringing together the scientific worker and the practical man, will result in a sounder appreciation of the rôle that the science of genetics can play in agricultural practice.

MESSRS. BURROUGHS WELLCOME AND CO. have issued their annual booklet, " Foresight in Photography," which may be obtained free on application to them. It contains a classification of plates and films according to their development speeds, time-tables for development, information as to " tabloid " preparations, and other useful matter.

DR. C. S. MYERS has edited and the Cambridge University Press will shortly publish " The Proceedings of the Seventh International Congress of Psychology," containing contributions on the conception of mental and nervous energy ; the classification of the instincts ; the nature of general intelligence and ability ; the principles of vocational guidance ; the present position of vocational testing in Germany ; an experiment on indirect measures of fatigue ; the cardio-vascular changes in mental work ; psychic asthenia and atony ; the psychic-galvanic phenomenon in dream analysis ; religion and psychoneurosis, and symbolism in folk lore.

WE regret that there are two typographical errors in the reference to a turbo-generator exhibited by the General Electric Company at the British Empire Exhibition which appeared in our issue of June 7, p. 826, second column, third paragraph. This machine has a capacity of 5000 kw., not 50 as stated, and the speed is 3000 revs. per min., not 300 as given.

Research Items.

MAORI STRING GAMES.—Some further examples of Maori string figures are given by Mr. J. C. Anderson in the March number of the *New Zealand Journal of Science and Technology*. One of these, known by the name of Tahitinui and collected from a Whanganui man at Kariniti, in its final figure is the same as one called the Osage diamonds from Pawhuska, Ohlahoma, and an unnamed figure collected by Dr. W. H. Furness in the Carolines. It differs entirely, however, from the latter in method of construction, whereas the points in which it is at variance with the Osage figure appear to be due to faulty memory. It is evident that many of the figures have had stories connected with them, but most of these have now been forgotten. One figure is known as *mouti*, "a trap," because it is said to have been used to catch Kae, who killed and ate the pet whale of Tinirau. Girls sent in search of Kae by Tinirau tricked him into revealing his identity by repeating the verses which accompany this figure. When he laughed he revealed the missing tooth by which they had been told to recognise him. Dr. P. Buck (Te Rangi Hiroa) has succeeded in recovering the whole of these verses. They reveal an extraordinary knowledge of details of anatomy and are characteristic of the Maori sense of humour. On both accounts they are untranslatable.

EXCAVATIONS AT BETHSHEAN.—Mr. Clarence S. Fisher summarises in vol. xiv. No. 4 of the *Museum Journal* (Philadelphia) the results obtained by the University Museum of Philadelphia expedition to Palestine, of which he is Director, in the years 1921–1923, at Beisan. Only a small part of the site has been attacked—the mound of Tel el Husn and the cemetery on the north bank of the Jalûd. The strata of the mound extend from an Arab settlement, *c.* A.D. 800, down to a mud-brick structure, with characteristic ledge-handled jars, of the early Bronze Age dating from, at least, 2000 B.C. This is at a depth of 36 feet, but the excavation has not yet reached rock. From evidence afforded by a well which shows the ends of a succession of mud-brick and rubble walls, it is expected that further exploration will reveal a sequence of strata dating back to 3000 B.C. and possibly to an original neolithic settlement. Among the buildings revealed was an Egyptian fortress with stelæ of Seti I. and Rameses II., and a seated statue of Rameses III. The inscription on one of these finds furnishes some interesting details relating to local campaigns of Seti I. and identifies the site with the city mentioned in the El Amarna correspondence. The stela of Rameses II. is the one which contains the reference to the employment of Semites to build his name city in the Delta, which is regarded as a possible confirmation of the Biblical record of the building of the city of Rameses by the children of Israel.

TUNGUS SHAMANISM.—Prof. Shirokogoroff, in the Journal of the N. China Branch of the Royal Asiatic Society, vol. liv. pp. 246-9, analyses the general theory of Shamanism among the Tungus. The primary condition for the existence of Shamanism is animism, and its principal characteristic is recognition of the ability of some persons to possess spirits, and by their aid, and by the use of particular methods unknown to other men, to know phenomena of a supernatural order. The Shaman therefore has special rites, clothing, instruments, and social position, setting him apart from other individuals who may, however, enter into communion with spirits by other methods. The Shaman must fall into an ecstasy during his ceremonies in order that his control of his own consciousness may, so far as possible, be eliminated, and physically and mentally he should be thoroughly healthy, as any abnormality might interrupt his ecstatic state at a critical moment. The nervous and psychical weaknesses to which the Tungus clans are subject wax and wane; but their influence may be checked when the harmful ghosts are subjected at the crisis to the "Master"—the Shaman. Thus Shamanism is correlated to the spread of nervous and mental disorders, and the Shaman acts as a safety valve. In origin, therefore, it is an unconscious measure of self-defence on the part of the clan. The Shaman, however, is himself subject to nervous depression, and falls under the influence of his own spirits who become restless and dangerous to the clan. The general conclusion is that the theory of ghosts or spirits and of their relation to man are the forms that to the mind of the Shaman generalise all phenomena of normal and pathological psychic life. The Shaman and Shamanism are the means of regulating these phenomena, and are *par excellence* hygienic and preventative.

SPECIFICITY OF HERPETOMONAS IN FLIES.—The type of Herpetomonas known as *H. muscæ-domesticæ* was found by Elery R. Becker (*Journ. Parasit.*, vol. 10, pp. 25-34, 1923) to be entozoic in the alimentary canals of the following muscoid flies: *Musca domestica*, *Phormia regina*, *Lucilia sericata*, *Sarcophaga bullata*, *Cochliomyia macellaria*, and *Calliphora erythrocephala*. The flagellate from "wild," naturally infected flies of any one of these six species was found to be capable, when inoculated by the mouth, of producing a natural infection in clean, laboratory-bred flies of the other five species. Such infected flies are "carriers," capable of infecting other flies by fæcal contamination of the food or the proboscis of the fly. The author concludes that it is extremely probable that *Herpetomonas muscæ-domesticæ*, *H. luciliæ*, *H. sarcophagæ*, *H. calliphoræ*, and the Herpetomonas from Phormia and Cochliomyia all represent the same species.

DURATION OF LIFE IN DROSOPHILA.—In a contiuation of studies on the duration of life, Prof. Raymond Pearl and Sylvia Parker (*Amer. Naturalist*, vol. 58, p. 193) have made an interesting experimental and statistical analysis of the duration of life in Drosophila under conditions of complete starvation. Having formerly shown that, under conditions of feeding, the wild flies had an expectation of life practically three times as great as in the mutation with vestigial wings, they now find that under starvation conditions the mean length of life is the same in both, *i.e.* about 44 hours for males and 50 hours for females. Under conditions of starvation, the variability in length of life is also much reduced, but the relative difference in length of life of the sexes remains the same under conditions of feeding or of starvation (*v.* also NATURE, June 14, p. 854).

NEPHRIDIA OF WORMS.—Five years ago Prof. K. M. Bahl, now professor of zoology in the University of Lucknow, described for the first time a new type of nephridium in Indian earthworms of the genus Pheretima. These nephridia are very remarkable from the fact that they discharge their secretion into the alimentary canal instead of on to the surface of the body, a possible adaptation for the purpose of conserving the water supply in a very dry climate. Prof. Bahl has now discovered a similar "entero-nephric" system in another Indian genus of Oligochæta, Lampito. Whereas, however, in the genus Pheretima the nephridia in question are of the so-called micronephric type, being minute and multiple, those of Lampito are large, paired meganephridia, one pair in each segment (with certain exceptions). They communicate with the cavity of the intestine by means of a system of ducts, of which the chief is the longitudinal supra-intestinal duct. There are, indeed, three very distinct types of nephridia in Lampito, namely, (1) the paired meganephric and enteronephric septal nephridia above referred to, the nephrostomes of which lie in the normal position in the segment in front of that in which the coils of the nephridium are situate; (2) micronephric and exonephric integumentary nephridia, which open by separate nephridiopores on the surface of the skin; and (3) enteronephric pharyngeal nephridia which open into the pharynx through bundles of ductules. The author suggests in his recently published memoir in the *Quarterly Journal of Microscopical Science* (vol. 68, part 1) that the old classification of nephridia into mega- and micronephridia should be abandoned, as it depends merely upon size, and should be replaced by the distinction between exonephridia, discharging on to the surface of the body, and enteronephridia, discharging into the alimentary canal, and that a further distinction should be recognised in each of these types according to whether there is or is not an open internal funnel.

CYTOLOGY OF THE SALICACEÆ.—Miss Kathleen B. Blackburn and Mr. J. W. Heslop Harrison have recently published a preliminary account in the *Annals of Botany* for April, of the results of their cytological examination of many species in the difficult systematic group of the Salicaceæ, which will be of great interest to both cytologists and systematists. The fundamental chromosome number in both Salix and Populus proves to be the astonishing figure nineteen; in Populus, in addition to the typical diploid forms, *P. balsamifera* is tetraploid; in Salix both diploid, tetraploid, and hexaploid forms were found, and the authors conclude that tetraploidy has originated independently in the two subsections Pleiandræ and Diandræ. *Salix triandra* has yielded a form with 22 chromosomes as well as one with 19, and as *S. phylicifolia* has a reduced chromosome number of 44, a second orthoploid series is thus indicated in the genus. Of three recognised Salix hybrids examined, two behaved quite normally during meiosis, and the authors conclude that hybridity with successful segregation in F1 and subsequent generations explains the variability of certain Salix species. Systematists will be interested to learn that on the basis of chromosome number, *S. caprea* is easily distinguished from *S. cinerea* and *S. aurita*, and also *S. Andersoniana* from *S. phylicifolia*. The authors state that an indication of the existence of heterochromosomes in the male of both Populus and Salix is being further examined.

THE SALTON SEA REGION.—Water-supply Paper 497 of the United States Geological Survey consists of a monograph on the Salton Sea region of California by Mr. J. S. Brown. The arid regions of the United States cover about half-a-million square miles, but the present monograph is confined to a small part of that area and deals with the most arid part of the country. Until a survey of the watering places was made, many parts of it were very poorly mapped. While the volume contains chapters on the general physiography, climate, and flora of the region, most attention is paid to water supply. Apart from an average rainfall of not more than 5 inches a year, the water of value for irrigation purposes comes from the Colorado River or wells in certain basins. The distribution, origin, and mineral content of the well water, which has great importance, is discussed in detail. The paper is supplied with large-scale map and complete bibliographies.

SURVEY WORK IN ERITREA.—Some interesting survey work was recently carried out in the little-known volcanic region of southern Eritrea, the strip of Italian territory lying between Abyssinia and the Red Sea. The expedition, which was under the auspices of the Italian Government, was primarily for geological exploration, but the geographical results were of importance and are incorporated in a map on a scale of 1 : 500,000 of Central and Southern Dancalia, published in Bolletino della Reale Società Geografica Italiana for March-April, 1924. Prof. P. V. de Regny, to whom a great deal of the field work is due, contributes an article giving the positions of various places on the map and some useful itineraries and notes. The map extends from French Somaliland to about lat. 14° 40′ N., and from the Red Sea coast to the frontier lands of Abyssinia. It is naturally far from complete, but is an advance on previous maps of this region.

BRITISH CLIMATE IN HISTORIC TIMES.—In his presidential address to the Geographical Association, issued in the *Geographical Teacher*, No. 68 and 69, Sir Richard Gregory brings together some useful facts bearing on the much-debated question of possible changes in British climate within historic times. Documentary evidence is collected from literature from the eighth century onwards, this type of evidence being of course merely qualitative but the only kind available until about the eighteenth century. A mass of useful meteorological computations are recorded. These deal mainly with the London district. Several interesting truths emerge from these figures. A very dry year is not infrequently preceded or followed by a very wet one, or, more usually, two dry years are followed by a wet one. The popular association of snow with Christmas finds no confirmation in meteorological data. Even frost at Christmas, at any rate in the London district, is a relatively rare occurrence. Exact observations do not exist for a sufficiently long period to enable us to decide with certainty that there have been progressive changes or definite cyclic variations in British climate. Evidence of abnormal periods occurs, but no cycle of practical service has been established even if several of academic interest may possibly exist.

WEATHER AT FALMOUTH IN 1923.—Falmouth Observatory has recently issued its annual report for 1923, prepared by the honorary secretary, Mr. Wilson L. Fox, and meteorological notes and tables for the year by Mr. J. B. Phillips, superintendent of the Observatory. The report states that the Observatory was open to visitors from 2·30 to 4·30 on Wednesday afternoons, an advantage to students and many others. Weekly, monthly, and annual results are supplied to the Meteorological Office of the Air Ministry. The notes and tables give 51·2° F. as the mean temperature for the year, which is 0·5° above the normal for 50 years ending 1920; the mean for February, 46·9°, is the highest on record for the month. The maximum for the year was 84·9° on July 12, which is the highest recorded at the Observatory. There have been only two other readings above 80°; these were 80·2° on August 6, 1916 and 82·8 on July 18, 1921. Of 201 stations making returns to the Air Ministry from England and Wales, 147 recorded higher maxima than that at Falmouth. The lowest temperature was 29° on November 20, and this is the only month during the year with a frost in the shade. The total rainfall for the year was 45·39 in., which is 0·22 in. below the normal. Bright sunshine totalled 1746·9 hours, which is 6·2 hours below the normal. November was exceptionally sunny, the record, 145 hours, being 30 hours more than any previous record for the corresponding month; the percentage of possible duration was 54, which is stated to be the highest recorded at any station in the British Isles. September had more sunshine than any corresponding month since 1914. The tables given in the report are of considerable interest.

TROPICAL CYCLONES.—In his presidential address to the Section of Physics and Mathematics of the tenth Indian Science Congress, Dr. S. K. Banerji reviewed the present position of our knowledge regarding the origin and causes of tropical cyclones. The contributions to this branch of meteorology of Hann, Lodge, Dines, Bjerknes and Shaw are considered and none of them found to give a satisfactory explanation of the phenomena. The recent work of Shaw contained in his essay "The Birth and Death of Cyclones" naturally received the most attention. Dr. Banerji considers that the air currents on the two sides of the "trough of low pressure" which exist over Northern India during the monsoon may be the origin of the storms which form at the head of the bay during that season, but he is unable to accept Shaw's explanation of the subsequent development and progress of tropical cyclones. He concludes by admitting considerable progress in the development of the theory of cyclones, but considers that many more data, especially from the upper air, are required before much further progress can be made.

WHEN TO STOP RETTING FLAX.—Dr. J. Vargas Eyre and Mr. C. R. Nodder seem to break new ground in the experimental retting of flax straw in a paper published in the Journal of the Textile Institute, vol. 15, May 1924. They plot the acidity, temporary and permanent (after removal of carbon dioxide), produced in the stagnant ret, pointing out that the curves seem to indicate the successive development of four stages which they interpret in chronological order as (1) fermentation of soluble sugars, etc., with rapid rise of acidity and frothing; (2) fermentation of soluble pectin, etc., accompanied by scum formation; (3) the main fermentation of the pectin of parenchymatous tissue with a consequent loosening of the fibre bundles; (4) a very slow increase of permanent acidity as the pectin of the middle lamellæ, cementing together the fibres in the bundle, is attacked. They point out that in practice the ret should be stopped in stage 4 and hope as a result of examination of factory practice in the light of this work to show that their data provide clear indication as to how the duration of the ret should be controlled. For practical purposes conductivity measurements can replace the titrimetric determination of acidity, the same stages being indicated on these curves as upon the acidity curves. The "dionic water tester" has proved satisfactory in practice for these conductivity determinations, and as this method is but little affected by the carbon dioxide in the retting water, it would appear that a very practical method of control of retting may develop out of these experiments by the staff of the Linen Industry Research Association.

AN ACOUSTIC SPECTROSCOPE.—At the second annual conversazione of the Royal Society held on June 18, Dr. Fournier d'Albe showed a set of resonators in the form of an "acoustic spectroscope." Each resonator was a Helmholtz resonator provided with a mica reed fixed opposite the opening. The reed was provided with a small mirror which reflected a pencil of light upon a ground-glass screen. The light being a linear source, the images on the screen were a series of short straight lines, each of which was drawn out into a band on sounding the corresponding note. Selectivity was complete within half a semitone, and the response being practically instantaneous it was possible to follow a piece of music and identify the notes as they occurred.

LONG-DISTANCE PROJECTION OF LARGE AUTOCHROMES.—M. Louis Lumière has solved the difficulty of providing a projection lens suitable for giving an image of 7 in. × 5 in. autochromes on a screen that is 55 ft. from the lantern, as in the large lecture hall of the Sorbonne (*British Journal of Photography*, Supplement, June 6). The lenses hitherto available for the purpose, as they must have a focal length of 40 inches or more, are of relatively small aperture, of impractical dimensions, and of prohibitive price. The arrangement consists of two equal plano-convex lenses mounted in a plain wooden box with the convex sides inwards, and with a separation equal to two-thirds of the focal length of each of the single lenses. The combination is in principle the same as that of the ordinary Ramsden eyepiece. The lenses actually used were 8 in. in diameter and of 55 in. focal length. The focal length of such a combination is equal to $\frac{3}{4}$ the focal length of one of the components, and it should be borne in mind that the nodal points are crossed, and that their separation is equal to $\frac{1}{3}$ the focal length of one component. The focal length of each lens is equal to $\frac{4}{3}$ of the desired focal length of the whole.

"DAVON" METALLURGICAL MICROSCOPE.—When the "Davon" Super Microscope was put on the market a few years ago it met with severe criticism mainly because its chief object appeared to be the production of high magnifications unaccompanied by the necessary resolution of detail. Recently, however, the makers, Messrs. F. Davidson and Co., 29 Great Portland Street, London, W.1, have had the assistance of Dr. Rogers in re-designing the instrument, and the new metallurgical form which is now on the market is a great improvement on the old one. The makers have apparently realised that mere magnification is useless, hence the objectives they now list have numerical apertures which are suitable for the work for which they are recommended. The distinguishing feature of the original Davon microscope, that of using a secondary objective to magnify the image formed by the primary objective, is still adhered to; with the magnifications now recommended, however, the secondary objective appears to function merely as a rather elaborate ocular. The use of a projection ocular in addition to the secondary objective is apparently now recommended only for very high magnifications (*e.g.* 2000–5000 diameters) taken with a 2 mm. objective as primary. Such high magnifications can only be regarded as enlarged pictures of what the same objective would give at about 1500 diameters, and the examples given in the "Davon" booklet do not lead one to modify the opinion that, when required, they can be obtained quite as well by enlarging a negative taken in the ordinary way at about 1500 diameters. In addition to the ordinary form of Davon microscope the makers also list a new model (the Davon "Metal Works") intended for taking photomicrographs rapidly at one standard magnification. For those who wish to take photomicrographs "by the score" at one fixed magnification the apparatus may probably be of use; one wonders, however, what the real value of such photomicrographs would be.

A Temple of Science.

DEDICATION OF A NATIONAL BUILDING AT WASHINGTON.

THE new building of the U.S. National Academy of Sciences and National Research Council (Fig. 1) was dedicated on April 28, in the presence of a large and representative assembly. Owing to repeated delays in the construction of the building, due to strikes and other causes beyond the control of the building committee, the date of its completion could not be certainly fixed in advance. For this reason the National Academy was forced to give up its intention to invite European and other academies and societies to be represented at the opening ceremonies.

In order to provide a suitable building for the National Academy of Sciences and the Research Council, the Carnegie Corporation of New York gave five million dollars to the Academy in 1919. The greater part of this sum, however, is to constitute a permanent endowment in the hands of the Academy for the maintenance of the building and the support of the work of the Research Council. The building itself has cost about 1,450,000 dollars, and the land on which it stands was purchased by the National Academy of Sciences for 185,000 dollars, raised by subscription.

FIG. 1.—New building of the U.S. National Academy of Sciences and National Research Council.

The main floor of the building contains a library, reading room, small lecture room and meeting room, and a central auditorium, surmounted by a dome about sixty feet high, surrounded by seven exhibit rooms. On the second and third floors are offices, occupied by the Academy, the Research Council, and certain closely related bodies.

The architect of the building, Bertram Grosvenor Goodhue, has adopted a simple classical design, richly embellished with appropriate sculptural and mural decorations. The massive bronze entrance doors, by Lee Lawrie, admirably depict eight episodes in the history of science, from Aristotle to Pasteur. The marble pseudo-pediment above the doorway portrays the sculptor's conception of the elements with which science deals—earth and cloud through the various forms of the animal and vegetable kingdoms to man, surmounted by the sun, the source of warmth and light. In a series of six large bronze panels (Fig. 2) filling the space between the upper and lower windows on the chief façade, Lawrie has represented the outstanding founders of science from Greek to recent times. Other sculptural work by the same artist includes elaborate grilled screens of bronze and glass at either end of the entrance halls, figures of Night and Morning in the central hall, a portrayal of the development of the art of writing from cave man to medieval scribes on the chimney piece of the library, and other beautiful details throughout the building.

The four arms of the cruciform central auditorium are vaulted to support a pendentive dome. The walls to the centre of the arches are of acoustic tile, and the dome is of the same material, elaborately decorated with emblems and figures symbolic of the sciences, the whole richly coloured and gilt by Miss Hildreth Meiere. The figures in the pendentives represent the elements of the Greeks—Earth, Air, Fire, and Water—while the soffit arches bear the insignia of Alexandria, the great academy of antiquity, and of the three historic national academies of Europe: the Accademia dei Lincei of Rome, the Académie des Sciences of Paris, and the Royal Society of London. The inscriptions encircling the dome are: "Ages and Cycles of Nature in Ceaseless Sequence Moving," near the apex, and the following characterisation of the various aspects of science in the zone at its base: "To Science, Pilot of Industry, Conqueror of Disease, Multiplier of the Harvest, Explorer of the Universe, Revealer of Nature's Laws, Eternal Guide to Truth."

A striking decorative feature of the central auditorium is a mural painting, by Albert Herter, of Prometheus lighting his torch at the chariot of the sun, thus bringing fire (typifying knowledge) to earth for the benefit of mankind, inscribed below with a quotation from the "Prometheus Bound" of Æschylus.

Other mural decorations by Herter will include the arms of eight historic universities—Bologna, Paris, Oxford, Cambridge, Heidelberg, Leyden, Harvard, Yale—in the reading room, and Abraham Lincoln, Joseph Henry, Louis Agassiz, and other founders of the National Academy in the meeting room.

The purpose of exhibits in the building is to illustrate current or fundamental phenomena of Nature and the progress of scientific research. Some, which are permanently installed, are arranged to show such phenomena as the changing spots on the rotating sun, the variations in the earth's magnetic field, and the records of earthquakes, wherever they occur. Others, which can be operated by the visitor, reveal the exquisite structure and gorgeous colours attending the formation of crystals in polarised light, the interference fringes with which Michelson measured the length of the standard metre and the diameter of giant stars, and the effects of electric discharges in rarefied gases. Still others, to be changed from time to time, are to illustrate recent discoveries and advances in science.

At the dedication ceremonies, the chair was occupied by Prof. Michelson, and the Bishop of Washington opened them with an invocation. He was followed by Mr. Coolidge, president of the United States, and succeeding speakers included Dr. J. C. Merriam, president of the Carnegie Institution; Dr. Vernon Kellogg, permanent secretary of the National Research Council, and Mr. Gano Dunn, chairman of the Building Committee. The building owes its existence chiefly to the conception and tireless devotion of Prof. G. E. Hale, and tribute was paid to him by more than one speaker during the dedication. The opening was marked by two tragic events, which were felt very keenly by all who participated in it. One was the death three days before of the architect, Mr. Bertram Grosvenor Goodhue, of New York, and the other was the sudden death, on the speakers' platform, of Dr. Ernest Fox Nicholls, the distinguished physicist.

We are glad to be able to give the subjoined extracts from some of the speeches.

Mr. Calvin Coolidge, President of the United States.

If there be one thing in which America is pre-eminent, it is a disposition to follow the truth. It is this sentiment which characterised the voyage of Columbus. It was the moving impulse of those who were the leaders in the early settlement of our country, and has been followed in the great decisions of the nation through all its history. Sometimes this has been represented by political action, sometimes by scientific achievements. On this occasion, the emphasis is on the side of science.

By science I mean the careful assembling of facts, their comparison and interpretation. Of those who are entitled to high rank in both our political and scientific life, perhaps Benjamin Franklin was the earliest and one of the most conspicuous examples. But it is the same spirit that has moved through all our life, which makes it particularly appropriate that our national Government should be active in its encouragement of the searching out of the truth in the physical world, and applying it to the well-being of the people, as it is interested in the searching out of the truth in the political world, with the same object in view.

President Washington, in his farewell address to the American people, said: "Promote, then, as an object of primary importance, institutions for the general diffusion of knowledge. In proportion as the structure of a government gives force to public opinions it should be enlightened." It was the first president of the United States who saw the necessity of research in this country. Jefferson, our third president, was himself a research worker by natural gift, and loved the problems which gave him a broader knowledge of our national surroundings. The beginning of our government, therefore, had to do with the inception of scientific research in the United States.

American science may be divided into five periods—the Jefferson period, that of Silliman, the Agassiz period, the present period of co-operative research when no one dominates, and the future for which definite foundations are being laid.

The Jefferson period began even before Jefferson's term as president. Palæontology in the United States had its beginning in the publication in 1797 of Jefferson's paper on Megalonyx or great claw. The first large palæontological laboratory in this country was in the East Room of the White House, where Jefferson arranged his fossils for study.

The Silliman period covers largely the first half of the last century. During this time the National Institution for the Promotion of Science and Art was established in the national capital, which promised to be a rival to the American Philosophical Society in Philadelphia. Meanwhile, the American Association was started. Also, in this period, an ex-president of the United States was concerned in the founding of an institution for research. John Quincy Adams in his own handwriting amended the Bill to establish the Smithsonian Institution, giving it the broad scope which it has to-day.

The third period, that of Agassiz, again brings a president forward in the promotion of science. Abraham Lincoln, deeply interested in the welfare of the American people, confessed that up to the time when he became president and talked with Joseph Henry, then head of the Smithsonian Institution, he was inclined to view the Institution as a rather useless government luxury, but he said, "It must be a grand school if it produces such thinkers as he." Later on in 1864, when the very foundations of the nation were shaken with civil war, the same president looked from the executive mansion on the Smithsonian building which was burning, and remarked to some military gentlemen present: "Gentlemen, beyond is a national calamity. We have no time to think of it now; we must attend to other things." It was in these days of strife that a senator from Massachusetts, Henry Wilson, later vice-president, put through the two houses of Congress a bill incorporating the National Academy of Sciences in the United States of America. President Lincoln signed the bill. Just how much the war influenced the recognition of necessity for such a body is not known, but war problems were assigned to the Academy and acted on. Since then many government scientific questions have been referred to it by the president, members of the Cabinet, and committees of Congress, and the Academy members have lent themselves to the work of solving these problems, knowing that their only compensation would be the knowledge that they had served the Government of the United States to the best of their ability.

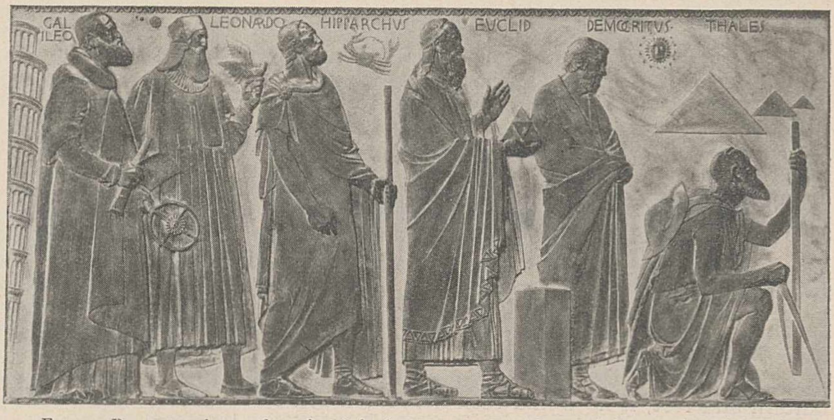

FIG. 2.—Bronze panel, one of a series of six, between upper and lower windows on the chief façade.

The period of individual work in science continued in America up to the time of the War. Then a change came over the established methods of warfare. Instead of individual fighting individual, it was masses against masses. Scientific problems in research for the solution of war matters could not, therefore, be solved by one man, but must be worked out by those interested in the same field. Realising this fact, and knowing of the many experts in the various fields of science covered by the Academy, a request was made to President Wilson by the Academy to call the leading scientific men of America for service under the guidance of the National Academy of Sciences and to organise a body to solve problems which required co-operative research. Thus began the National Research Council, and later the Council of National Defence requested it to act as the department of research of that body.

After the armistice was signed, the president of the United States, appreciating the value of what had been done, requested the National Academy of Sciences to reorganise the National Research Council under its charter, on a permanent peace basis, and with this request, co-operation in scientific research was given a firm foundation. Upon the assumption of this added responsibility, it was found that the old quarters of the Academy at the Smithsonian Institution were not adequate. A number of philanthropists who recognised what splendid work could be done if ample space and facilities were available, contributed a sum sufficient to secure the lot on B Street, between 21st and 22nd, and C Streets. The Carnegie Corporation of New York then donated the building, which may be termed the Temple of Science in America. It is not a place of mystery, but one to lead the public in thinking deeply and seeing how research can explain fundamental problems.

Nothing with more promise than the fifth period, that of the future of American science, could come to the American people. The scientific man is rending the earth to reveal its secrets. Truth must prevail for the betterment of mankind, and with the energy that the men of science are putting into the problems of research, Diogenes would certainly have a chance to lay down his quarter-staff and lantern and rest, if he would turn his search in their direction.

This magnificent building now being dedicated to science predicts a new day in scientific research. A new sun is rising. It is destined to illuminate the scientific world by illuminating this hall.

One of the most important possibilities for service of the National Academy of Sciences in the future lies in its opportunity for inspiring the people of America to insistence upon having the truth, and nothing but the truth, regarding everything that touches our life as a nation. It is always to be borne in mind that while the peculiar relation of the Academy to the Government of the United States may concern the conduct of specific researches, the example of dignified emphasis upon the truth as reached by correct thinking in every department of research, and in its practical applications, may be a contribution of inestimable value to the whole people.

It is for this purpose that the Government sets its stamp of approval upon this effort, and joins in dedicating this building to the betterment of the human race by achieving a clearer knowledge of the truth.

DR. JOHN C. MERRIAM, VICE-PRESIDENT OF THE NATIONAL ACADEMY OF SCIENCES.

The ceremonies in which we participate to-day bring to us, in what seems like sudden fruition, the results of the vision, the plan, and the hopes of many years. Knowing as we do that the joy in recognising advance is itself essential to progress, this would seem the natural time to halt for a moment of pure pleasure in contemplating the attainment. But more important to us than mere appreciation of accomplishment is the realisation that this is also a time at which we should consider with the utmost care what those newly established conditions mean in terms of further opportunity. We must not fail to realise that these pleasures of possession have intimate relation to responsibility for that which we have helped to create, as also for the new and great possibilities of service now opened. So while this is first a day of rejoicing that possessions have been secured and ideals have been realised, it is most of all a time for earnest consideration of the great things this advance may mean for the Academy and for the people of to-morrow.

In viewing the future responsibilities of the Academy to the Government, we may not interpret this relation to mean merely the possibility of assistance in specific problems or researches as they may happen to arise either in relation to national defence or in other connexions. There can be no doubt that this body was chartered with the understanding that it would have always in mind the interests of the people in whatever ways science can contribute to meet their needs or support their ideals. Though it is clear that the Academy represents expert knowledge in the sciences only, it is important that its vision of ultimate service reach over all phases of the nation's life and thought, ranging from defence to assistance in securing those guarantees of comfort and health in body and spirit which make good citizenship and happiness possible.

Now, for the first time, we are to have a home, with all this means, as a place in which to live and to work. It seems clear, as one of its responsibilities, the Academy, with its relatively small membership, comprising all of the sciences, should look forward to its general and special meetings here as exceptional opportunities for bringing the whole range of scientific inquiry to bear upon new discoveries or upon great investigations in progress. Even more important than the general meetings will be the possibilities of those frequent intimate conferences of small groups brought together for discussion of special topics, in which, with a minimum of formality, the more fundamental discussion of the great problems is made possible.

The bringing of the National Research Council into being on the foundation of the Academy Charter has extended greatly the possibilities for stimulation and organisation of research. In occupying its quarters in the new building, the Academy will come into a relation to the Council which will bring out more clearly than at any earlier time the significance of the organisation which it has brought into existence. The invitation to a large group of the national scientific societies of this country to participate in the work done through the National Research Council has developed a wide range of relationships of the greatest importance. The responsibilities and opportunities which present themselves to the Academy in connexion with future problems of the Research Council must be reckoned as among the most important which will now come closely to our vision.

In the future development of our foreign relations in scientific work appears also one of the very great opportunities for national service. There is good reason for believing that the possibility of some of the surest ties to be formed between the nations lies in the discussion of scientific and intellectual questions, in which international co-operation is directed specifically toward search for the truth without reference to its immediate economic or political bearing.

Along with those relationships of the Academy which have been considered, there is also open to this body, as to other scientific agencies, an exceptional opportunity and responsibility for aiding in steadying the thought of the people by interpreting in some measure the meaning of the rapid advances now being made in scientific understanding of man and his environment. With the continuing growth of knowledge we see the universe increase in complexity and extend itself vastly in space and time. It is to be expected that adjustments in our scientific data will bring into continuous review much that pertains also to the fundamental philosophic and religious thought forming so important a part of the world's thinking. We should never blind ourselves to the fact that the people have philosophies now, and always will have them, and that consciously or subconsciously they have religious beliefs, also. Abundant national disasters, some of which we have seen in recent decades, have demonstrated fully that there is nothing more deadly than bad national philosophy, especially if it translate itself into terms of economic or political policy. Such beliefs never arise from attainment of the truth, but always from the lack of it.

The Academy will always be conservative in holding fast such knowledge as may seem securely founded, but it will never look with favour on the defence of any view merely because it has been held. The attitude of the Academy as representing truth-seeking and truth-accepting should have a continuous influence in stabilising thought. Though we may never be advocates of philosophic or religious systems, we should assist in that interpretation of the shifting panorama which the world seems to present when viewed through the eyes of science; and we should help to keep false assumptions from serving in the place of truth.

DR. VERNON KELLOGG, PERMANENT SECRETARY OF THE NATIONAL RESEARCH COUNCIL.

The National Research Council was born of the National Academy of Sciences in strenuous days of war, even as the Academy itself was born during the throes of an earlier great conflict. Both came into existence for a first purpose of bringing science intensively to the aid of the nation in a time of terrible emergency. Science, which has been said to know no political boundaries, yet has its nationalistic phase. Scientific men also may be patriots.

Because of the rôle played by science during the War, and the even more important rôle it will inevitably play in the next great war—if such war must come—various philosophers and humanitarians have lifted their voices to decry science as an agent of evil and a promoter of human capacity to do grievous things. They charge against it not only its rôle in war, but also its rôle in the industrial revolution which has made too many men slaves of machines.

It is true that science has been used to do sad work. It is true that science can be used to make of the next war an earthly horror almost beyond conception. But is science to be held responsible if we choose to have war rather than peace? Let us put the responsibility where it justly falls: on governments and on ourselves. Because science can convert, in a day or two, a factory for the production of beautiful dyes, pleasant perfumes, and disease-destroying drugs into a factory for the production of high explosives and poisonous gases, is science to be judged an enemy of humanity? Scientific men will never make this conversion unless you ask them to. They hope from their hearts that they will never again have to do this.

It is the other side of the picture that science prefers to have shown. It asks to have recognised the many contributions it has made to the well-being and happiness of mankind. It directs attention to its steady endeavour to satisfy the insistent demand of man to know the world he lives in, that he may live in it more comfortably and confidently and with more interest; to know the wide reaches of the universe that his mind and soul may understand humility and yet know exaltation. Science moves with constant acceleration in its work of increasing human knowledge, adding to human capacity and expanding human existence. By the very cumulation of knowledge more knowledge is made more rapidly possible. In the early days of prehistoric man before picture-making and writing, man could not cumulate knowledge, or, at best, but slightly and slowly. But with the perfecting of means of communicating knowledge from one group to another and from one generation to another, the advance and cumulation of knowledge can proceed rapidly and ever more rapidly. In the present quarter century more knowledge of the order of Nature has been gained than in any quarter century before. One cannot dream too wildly of the possibilities of the future.

Let science, then, with all encouragement, play undisturbed its glorious peace-time rôle of bettering the lot of individuals, adding to the resources of nations, and widening man's understanding of Nature and of himself. Let it go on in its great beneficences: conquering disease; ameliorating the wearing struggle for food and the cruel rigours of heat and cold; annihilating distance; reaping benefits from the oceans and forests, and bringing plants and animals to the service of man's sustenance and comfort. Let it continue to convert astrology into astronomy, alchemy into chemistry, guess-work into exact knowing. Let it use imagination to the limit—imagination is no less necessary to science than to the seven arts—but let its dreams be tested in the light of day. Let it prove all things, discover truth, and teach truth and the way of its discovery. Let it attend, undistractedly and unwearyingly, to its great effort to make our land a better land for our children and our children's children to live in, and the human future broader and better than the human present.

Annual Inspection of the Rothamsted Experimental Station.

THE annual meeting of the Society for Extending the Rothamsted Experiments was held at the Rothamsted Experimental Station, Harpenden, on Wednesday June 18, when about 70 members of the Society and guests attended at the invitation of Lord Bledisloe, chairman of the Lawes Agricultural Trust. Among those present were Mr. Noel Buxton (Minister of Agriculture), Lord Salisbury, Earl de la Warr, Sir Thomas Middleton, Mrs. and Miss Muller, Dr. K. Fisher (Headmaster of Oundle), and the members of the Lawes Trust Committee. Both Mr. Lloyd George and Mr. Stanley Baldwin were compelled to cancel their acceptance owing to other public business.

As in previous years, arrangements were made for the visitors to see something of the work of the Station, both on the experimental fields and plots and in the laboratories. There are more than 500 experimental field plots on the farm and 12 separate departments in the laboratories, so it is impossible in the course of a single day's visit to see more than a small section of the work.

The Rothamsted field plots fall into two groups:

the classical experimental fields, the treatment of which is continued unchanged, from year to year, and the later experiments, laid out to test some definite point under present-day conditions. The latter group are, in one sense, sets of temporary experiments, and as a rule are replaced by others after a few seasons. The long spell of wet weather over the early part of this year has not only encouraged weeds but has retarded the growth of cereal crops, and there has been a general levelling up of the differences between the plants on various plots that would be apparent at this time of the year in a normal season. On the other hand, the growth on meadowland and hay fields has been very satisfactory.

The morning inspection of the plots was arranged to show both these effects, the fields selected for this purpose being the Park Grass plots, which have been cut for hay each year since 1856, and Hoos Field, which has been under barley since 1852. The Park Grass plots are always of great interest to visitors owing to the remarkable changes, brought about by the various combinations of manures, in the quantity and botanical composition of the herbage that was originally uniform in composition throughout the field. The plots on Hoos Field, that are now carrying the seventy-third successive barley crop, were next visited. For many years past these plots have demonstrated the importance of phosphate in encouraging early growth and hastening maturity of the plant, and the influence of this factor and others on malting-barley, which is normally grown in rotation and not continuously on the same land, has for some years been under investigation both at Rothamsted and at a number of outside centres in connexion with the Institute of Brewing Research Scheme. In addition to the malting barley series, other groups of plots on the farm have been laid out to test certain points that have arisen directly or indirectly from the Hoos Field results. Among these may be mentioned the extensive series dealing with the effect of silicates. Lawes and Gilbert used silicates on certain of the Hoos Field plots—and on Park Grass plots also—in connexion with Liebig's famous theory of plant nutrition; the treatment was carried on without change although the necessity had apparently ceased, and it will now be possible to make important comparisons between these plots and the series recently set up.

After luncheon Lord Bledisloe, who presided, addressed the company. He read a letter from the Prime Minister, who said that the production of food had not moved on with the same rapidity as the production of the other great necessities of life like textiles and metals. The best hope of advancement in this direction was in the application of research to the industry of agriculture. After some appreciative references to the Rothamsted Station, the letter concluded by stating that the Government, as evidence of its belief in the research, had assured to agricultural research such sums as could be usefully expended.

Lord Bledisloe then dealt with the practical significance of the work, and in particular the extensive co-operation between Rothamsted and outside bodies which are sharing in the experiments, and in many cases contributing liberally towards the cost of the research. In conclusion he expressed his conviction that it is in times of depression in the industry such as we are now passing through, that the research stations and agricultural schools are of greatest assistance.

The Minister of Agriculture congratulated the Station on its past and present record, and said that he had been impressed in his travels abroad by the number of people who were familiar with the work of the Station.

The Director, Sir John Russell, briefly reviewed the past year's work, referring especially to the large increase in the number of farmer visitors, of whom there had been more than 1300 in the year, a number that will be considerably exceeded in the present season. In addition, some 70 lectures were given by various members of the staff during the winter, at farmers' and students' meetings. In dealing with the laboratory work, he invited attention to the relation of the research work to practical conditions as shown by the financial aid given by outside bodies to various departments. Typical cases of this co-operative work were as follows: Entomology Department and the Imperial Bureau of Entomology on the control of pests by means of parasites, Chemistry and Bacteriology Departments with the Royal Agricultural Society on green manuring and lucerne inoculation respectively, Physics Department with the Empire Cotton Growing Corporation in connexion with soil moisture and acidity investigations, and the Chemistry Department with the Institute of Brewing on malting barley investigations, and with fertiliser manufacturers in fertiliser investigations.

Lord Salisbury briefly traced the early relations of the Station with Hertfordshire farming.

Sir Daniel Hall, chief scientific adviser to the Ministry of Agriculture, and a former Director of Rothamsted, reviewed the progress that had been made since the Government first gave financial assistance for agricultural research, and Dr. J. G. Lipman, Director of the New Jersey Agricultural Station, New Jersey, U.S.A., gave some interesting comparisons between the British and American organisations for research and education. Mr. Martin Sutton and Mr. Stratton also spoke. Mr. Stratton paid his first visit to Rothamsted sixty-three years ago. The guests then inspected the laboratories and discussed with the staff some of the investigations in progress.

Association of Teachers in Technical Institutions.

THE annual conference of the Association of Teachers in Technical Institutions was held at Newcastle-on-Tyne on June 9 and 10. In his presidential address, Mr. F. C. Clarke, of the Technical College, West Ham, emphasised the fact that technical education is not at present understood by many of our educationists. Mr. Fisher, in an article in the *Teachers' World*, wrote that he was able to compare in their effects upon national power the expenditure in technical education and pure science, and to declare without hesitation in favour of pure science. What did Mr. Fisher mean by technical education and pure science? How can one be separated from the other? They merge into each other at innumerable points.

In Mr. Clarke's opinion, one pressing question is the need for a committee of inquiry to investigate the relationship of technical to other branches of education and to industry and commerce. Considerations of the future demand a vigorous healthy Britain, with its present young people properly educated and trained in the crafts and industries which the country is capable of supporting and extending. There is also need for the captains of industry to be more than business men; they must have a sure knowledge and experience of the technique of their industry based upon a sound technical education, and possess a wide human outlook and sympathy with their workers.

There is not equality of opportunity for the boy who wishes for an industrial career and proceeds to a technical school. There is a distinction between the secondary school and the junior technical school, created and maintained by the regulations of the Board of Education, which can only be regarded as a social one. In a junior technical school, the hours are longer, and the permitted syllabus restricted and curtailed. Permission to teach any language, other than English, is almost invariably refused. Boys enter these schools at the age of about 13 for a two years' course or at the age of 12 for a three years' course, and the progress of desirable boys towards a university degree or the diploma of the engineering associations is stopped, because these examinations require some knowledge of a foreign language. Boys from a junior technical school who wish to proceed further have to commence the study of a foreign language either in full-time day technical classes, or, after entering industry, in part-time evening classes. The time in these classes could be devoted wholly to professional studies if the language could be learnt earlier. One sequel to this is that the Matriculation Board of the Northern Universities has seen fit to introduce an alternative matriculation examination for technical students.

To all children, education from the age of 11-14 should be on secondary or secondary-technical lines. The child should be graded, and should have the benefit of specialist teachers, a wide choice of curriculum according to his needs, *i.e.* his present educational needs depending on his natural bent or bias, the benefit of uncrowded classes and practical science laboratories and workshops. If a name is required it might be called the junior or lower secondary stage.

At the age of 14, if the child is to continue full-time education, for whatever purpose—for the learned professions, commerce, industry, or what you will—there must be no social distinctions in the State-aided or controlled schools. The education up to the age of 16 must be a continuation of the junior or lower secondary work, but widened and varied to meet the needs and tinged with the colour of the coming career. This type of education must be as much technical with a secondary bias, as secondary with a technical bias.

From the ages of 16-21 the widening apart of the lines would be more marked. Some would continue with advanced studies in the secondary school, some at the technical school, until they reached the age of 18, but here there must be no overlapping. At eighteen many would proceed to the universities; others would continue work of university rank in the technical school. In teaching adolescents from sixteen onwards the technical school is fulfilling its highest function. It is the local college, the local university in all but name. Nearly all the modern universities have grown out of the local technical school, in some cases the Mechanics' Institute.

For those who leave school at 14, 16, or 18 years of age to enter industry, there are evening classes—after a full day's work, if they are not unemployed. For these students the only satisfactory system of continuing their general education, combined with training in their technical work, or to fit them for the higher positions in their career, is some form of "sandwich system"—a system in which periods of work and study are alternated with due regard to their requirements.

Viscount Leverhulme gave an interesting address at the second day's proceedings. The object of education, he said, is to enable us to lead happy and useful lives, and technical education ought to be in accordance with the after requirements of the pupil. Some have a prejudice against the university trained man in business. At the same time the best training is in the hard school of life, and practical experience should be interwoven with high technical qualifications. Much of the technical education imparted to students is not made use of in distant countries, whereas within the Empire we have the finest possibilities of development.

In education there are two human elements—the animal and the spiritual—and in the spiritual, where we are dealing with humanity, education is greatly lacking. Technical teachers have not only to produce technical experts to carry on the business of this great Empire, but also to produce men and women.

University and Educational Intelligence.

CAMBRIDGE.—The following re-appointments have been made: Dr. F. H. A. Marshall, Christ's College, to be reader in agricultural physiology; Mr. A. Amos, Downing College, to be University lecturer in agriculture; Mr. F. T. Brooks, Emmanuel College, to be University lecturer in botany; Mr. J. E. Purvis, Corpus Christi College, to be University lecturer in chemistry and physics in their relation to hygiene and preventive medicine; Dr. R. H. Rastall, Christ's College, to be University lecturer in economic geology; Mr. T. W. Landon, Clare College, to be University lecturer in mechanical engineering; Mr. H. Woods, St. John's College, to be University lecturer in palæozoology; Mr. T. S. P. Strangeways, St. John's College, to be University lecturer in special pathology; Mr. H. McCombie, King's College, to be University lecturer in chemistry; Dr. L. A. Borradaile, Selwyn College, and Mr. F. A. Potts, Trinity Hall, to be University lecturers in zoology; Mr. W. D. Womersley, Emmanuel College, to be demonstrator in mechanism and applied mechanics; and Dr. H. Hartridge, King's College, Dr. H. Roberts, Clare College, and Mr. T. R. Parsons, Sidney Sussex College, to be demonstrators in physiology.

Lieut. P. R. Antrobus, R.E., Trinity College, has been awarded the Rex Moir Prize in the Mechanical Sciences Tripos.

An election to the Charles Abercrombie Smith Research Studentship of 150*l*. a year for two years at Peterhouse for candidates for the Ph.D. degree will be made at the end of July. Applications must reach the Tutor, Peterhouse, not later than July 7.

The Committee on Geodesy and Geodynamics records the completion of the new Pendulum House near the University Observatory. Pendulum apparatus loaned by the Science Museum, South Kensington, has been erected and is in use along with some newly designed apparatus to connect gravity determinations at Kew and Cambridge and to throw light on a suggested change in the value of gravity at Dehra Dun in India during the past twenty years.

LEEDS.—Some time ago a movement was started through the University for raising a fund with the object of signalising the distinguished services which Prof. Arthur Smithells had rendered to the community in so many directions, and particularly to the science of chemistry and the University of Leeds during his thirty-eight years' tenure of office as professor of chemistry, which terminated at the end of the session 1922–1923. The fund has been generously supported, and all who have interested themselves in the movement will be pleased to learn that the attainment of its object is now secured. Mr. Fiddes Watt, R.A., has undertaken the commission to paint a portrait of Prof. Smithells for presentation to the University, and a fund of at least 2000*l*. will remain for the endowment of a scholarship in the University bearing the name of Prof. Smithells and instituted along lines approved by him. As the fund will shortly be closed, any further subscriptions to increase the value of the scholarship should be sent at once to the Treasurer, The Smithells Fund, Beechwood, Roundhay, Leeds.

DR. H. MARTIN LEAKE has been appointed Principal of the Imperial College of Tropical Agriculture in succession to Sir Francis Watts, who will retire next November. Dr. Martin Leake was formerly Director of the Department of Agriculture and a member of the Legislative of the United Provinces, India. In 1919 his services were lent to the Egyptian Government, which he advised on cotton, and last year he was a member of a joint commission with Sir John Russell to advise the Sudan Government on the organisation of agricultural research.

THE Commissioners for the Exhibition of 1851 have awarded Senior Studentships for 1924 to the following: (1) Mr. T. M. Cherry (Melbourne and Cambridge) for research in mathematics, on the recommendation of the University of Cambridge; (2) Mr. Malcolm Dixon (Cambridge) for research in bio-chemistry, on the recommendation of the University of Cambridge; (3) Dr. R. D. Haworth (Manchester) for research in organic chemistry, on the recommendation of the University of Oxford; (4) Mr. R. W. Lunt (Liverpool) for research in physical chemistry, on the recommendation of the University of London, University College; (5) Mr. G. M. Morant (London) for research in anthropology, on the recommendation of the University of London, University College.

THE progress of education in India, 1917–1922, is reviewed in a report recently issued by the Educational Commissioner with the Government of India (Superintendent of Government Printing, India, Calcutta, Rs. 1.6). The report, a very readable one, shows that throughout the quinquennium the course of educational administration was affected strongly by political movements. The years 1917–1920 saw a flood of ill-informed enthusiasm for "fighting illiteracy" and so enabling the masses to read political "literature" and ballot papers. Then came "non-co-operation" and the boycotting of schools recognised by Government, accompanied by the setting up of so-called national institutions showing no distinctive feature worthy of imitation and some highly objectionable. Some indication of the resultant changes is given in the following statistics of enrolments in each of the three years 1919–20, 1920–21, 1921–22: (000 omitted) Arts Colleges, 52½, 48, 46; High Schools, 632, 601, 595; Middle Schools, 650, 654, 645; Primary Schools, 6134, 6328, 6310. The leaders of this movement found an effective weapon in the growing dissatisfaction with the contents of the school and college curricula, and the Education Departments should profit by the attention thus directed to the necessity for a restatement of their educational aims. A particularly useful part of the report is a summary of the origins and points of resemblance and difference of the new universities. In this connexion, it is noteworthy that with the transfer of educational control from the central to the local government, there is a growing danger of an exaggerated provincialism, especially in higher education. The universities, as well as the Departments of Education, are helped to keep in touch with one another by the Bureau of Education and by the Central Advisory Board set up by the Government of India in 1921, but the project for an Association of Indian Universities debated at the congress, held in the same year, of all the universities of the British Empire, has not materialised.

Early Science at the Royal Society.

June 22, 1664. The dog, that had a piece of his skin cut off [for grafting purposes] being inquired after, and the operator answering, that he had run away, it was ordered that another should be provided against the next meeting for the like experiment, Dr. Wilkins and Dr. Charleton to have the better care.

June 23, 1686. A note from Mons. Justel was read, giving an account of a book about hygrometers then printing at Paris; that the hygrometer of the Society was the first.

June 24, 1663. Mr. Graunt mentioned that he knew a fishmonger, who in 1658 put three carps into a pond, which at the end of four years were multiplied into 875, the smallest of which were 15 or 16 inches long. He was desired to bring the story, with all its circumstances, in writing. And all those members, who had opportunity were to make several experiments on several fishes relating to their growth.

1669. The president having proposed from the commissioners of the navy, that the Society would undertake the weighing up of the wrecks in the Thames at Woolwich; upon debate, it was resolved, that his lordship should be desired to return this answer, that the Society being destitute of the necessaries for undertaking such a work were ready to give their assistance to his Majesty's officers therein, and to depute certain persons of their body to take care of the performance, referring themselves to his Majesty's gratification upon the effecting thereof.

June 25, 1684. There was shewn an account of the weather during the month of May last, as it was observed at Dublin by Mr. William Molyneux.

June 26, 1679. Mr. Hooke produced an intire cocoa-nut, which was newly brought from Barbados; and he caused it to be cut in sunder, and poured out of the middle of it a glass full of liquor . . . tasting sweetish and pleasant like an emulsion.

June 27, 1666. The experiments appointed for the next meeting were—The prosecution of a circular pendulum to be applied to a clock.—The two balls on a pendulum, to show the motion of the earth and moon, with the contrivance of a sand-box to have the sand run out, for representing the line of that motion.

1667. It was proposed to have a rarefying engine made of wood big enough for a man to sit in. This was approved of by Mr. Boyle. Mr. Hooke was ordered to have one made as soon as possible. He proposed a contrivance, which he had, to make a vessel [to] swim in under water, of any dimension, wherein he might pass as fast as in a wherry upon the Thames, and at any depth he pleased, with safety. He was ordered to compute the charge of such an engine, and report it.

1678. Mr. Wicks brought in and read a paper, delivered to him by some Quakers, concerning the great benefit that would accrue to the nation by the setting up and encouraging several new manufactures whereby to keep the poor at work. To which the Society returned for answer, that their address was more proper to the parliament, the matter not properly lying before the Society.

June 28, 1665. It was resolved that the public assemblies of the Society be henceforth discontinued [as from this date on account of the spreading of the plague] till summoned again. The members of the Society were then exhorted by the president [Viscount Brouncker] to bear in mind the several tasks laid upon them, that they might give a good account of them at their return; and Mr. Hooke was ordered to prosecute his chariot-wheels, watches, and glasses, during the recess.

Societies and Academies.

LONDON.

Zoological Society, June 3.—Prof. E. W. MacBride, vice-president, in the chair.—Miss Helga S. **Pearson**: (1) The skull of the Dicynodont reptile Kannemeyeri. (2) A Dicynodont reptile reconstructed.—R. I. **Pocock**: The external characters of the Pangolins (Manidæ).—J. P. Hill and E. A. **Fraser**: Some observations on the female urogenital organs of the Didelphyidæ.—Mary L. **Hett**: On a new land-Nemertean from New South Wales.—Hem Singh **Pruthi**: (1) On the post-embryonic development and homology of the male genital organs of *Tenebrio molitor* (Coleoptera). (2) On the development of the ovipositor and the efferent genital ducts in *Tenebrio molitor* (Coleoptera), with remarks on the comparison of the latter organs in the two sexes.—C. F. **Sonntag**: The comparative anatomy of the tongues of the Mammalia. X. Rodentia; XI. Marsupialia and Monotremata.

Linnean Society, June 5.—Dr. A. B. Rendle, president, in the chair.—Théodore **Monod**: A new type of Crustacea, *Thermosbæna mirabilis*. It has been found at El Hamma (Tunisia) in a spring which supplies with hot water a Roman bath. Its total blindness, absence of pigmentation, and marked negative heliotropism show that it normally inhabits the subterranean waters, and as the heat of the spring is 120° F. the crustaceans can endure at least that temperature. It seems to be a link between the Mysidacea and the Isopoda *sens. auct. vet.* (= Isopoda *sens. str.* + Tanaidacea).—Karel **Kruis** and Jan **Šatava**: The life histories of yeasts. By inducing endospore formation and cultivating the fungus from the ascus, "Springer," a Viennese pressed yeast, gave cultures differing from the normal form. The cells were only about half the size and were spherical rather than elliptical; they formed thick, compact, persistent colonies in place of being loose, radiating, and evanescent. The dwarf form retained its characters during several months. The most striking difference between the two forms is that the dwarf form does not form endospores when placed on gypsum blocks. Similar results were obtained with other yeasts; with the wine yeast "Melnik," the endospores either germinate directly and give rise to the dwarf form or else copulate in pairs and produce the normal form. It thus seems that there is an alternation of generations, the normal form being the vegetative stage and the dwarf form the sexual stage. One result is that it seems possible that the numerous "species" of Torula, so troublesome, particularly to medical men and to brewers, are really dwarf forms or strains of species of Saccharomyces; for example, "Hofbrau" yeast, which is of the typical "Frohberg" type in the normal (vegetative) form, is of the "Saaz" type in the dwarf (sexual) form.—G. **Erdtman**: Studies in the micropalæontology of post-glacial deposits in Northern Scotland. Pollen grains preserved in the peat were examined. A sample is taken by means of a borer to various depths and the cores obtained are sub-sampled, boiled with 10 per cent. caustic potash, and the pollen grains counted. Of the pollen identified, that of Betula is the most abundant, usually providing 70 per cent. of the total. Next in order come Pinus (14·6 per cent.), Alnus (11·8 per cent.), Salix (11·25 per cent.), Carpinus (4·25 per cent.), Quercus (2·4 per cent.) and Ulmus (1·2 per cent.). Beech, holly, and sycamore are rare. The first appearance of the pollen of Alnus probably marks a definite horizon; this may correspond to the level of the first appearance of alder pollen in Scandinavia. The latter is late Boreal or about 6000 B.C. A striking difference, as compared with Scandinavia, is the total absence of Picea. Carpinus has only been recorded hitherto from fossil deposits in Great Britain from pre-, late-glacial, and Roman deposits south of the Wash. The presence of Fagus, too, in these post-glacial peats of the North of Scotland rather negatives the idea that its present restricted range is the outcome of recent immigration. Pine pollen is always associated with that of birch; probably these two trees were the principal constituents of the post-glacial forests of northern Scotland.—C. C. A. **Monro**: Polychæta from the *Alert* expeditions. Polychæte worms obtained during the voyage of H.M.S. *Alert* in 1878 have hitherto remained unexamined. Some of the more interesting types were referred to; a species of Sigalion shows apparent conversion of the elytra into egg-pouches.

PARIS.

Academy of Sciences, June 2.—M. Guillaume Bigourdan in the chair.—Charles **Moureu** and Charles **Dufraisse**: Autoxidation and antioxygen action. The catalytic properties of sulphur and its compounds. Sulphur exerts as powerful an action as hydroquinone in arresting the spontaneous oxidation of benzaldehyde. An abstract of earlier work on the catalytic properties of sulphur and sulphur compounds is given. —H. **Deslandres**: Record obtained at the Meudon Observatory of the Courtine explosive wave. Second and third explosions. On May 23 the recording microphone registered three trains of waves, at intervals of about one second. The record on May 25, owing to interference by the wind, was not so distinct.—M. **Molliard**: The effect of the mineral composition of the nutritive medium on the structure of *Sterigmatocystis nigra*. An account of the changes produced in the mould by eliminating sulphate and potassium from the culture medium.—M. de **Forcrand**. The heat of vaporisation of carbon. An empirical modification of Trouton's relation is given; taking 4190° C. absolute as the boiling-point of carbon, this formula gives $L = 180,253$ for a gram-molecule of carbon.—Charles Robert was elected a member of the division for the applications of science to industry, in succession to the late Maurice Leblanc.—M. **Mandelbrojt**: Taylor's series capable of extension.—G. **Cerf**: The transformations of curves of space associated with transformations of contact.—Charles **Platrier**: The phenomena of torsion studied with the aid of the integral equations of Volterra and Fredholm.—M. **Fichter**: The variation of the coefficient of sliding friction with the state of the surfaces in contact. Measurements of the coefficient of friction have been made between different metals (iron on iron, brass on brass, steel on brass, and so on), and it has been found in all cases, starting with slightly rough surfaces, that the value of the coefficient of friction diminishes as the smoothness of the surface is increased, up to a certain "critical polish," after which the coefficient increases very rapidly as the surface becomes more perfect. The experiments of Johanson on the adhesion of such highly polished surfaces have been repeated, and an outline of a new theory of sliding friction based on these results is given.—Y. **Rocard**: The equations of motion of a gas.—J. **Pionchon** and Mlle. F. **Démora**: The formation, in the wet way, of layers of cuprous oxide possessing photo-electric properties. Two sheets of copper, placed in a millinormal solution of copper sulphate and exposed to the air, become covered with a thin film of cuprous oxide. The coated plates, standing in the copper sulphate solution, form a photo-electric cell which is very sensitive to the action of light.—A. **Cotton**: Remarks on the preceding communication. The recent work of G. Athanasiu appears to have anticipated to some extent the results described in the preceding paper.—B. **Szilard**: A new type of electrometer.—R. **Lucas**: Piezoelectricity and molecular asymmetry. There do not appear to be any exceptions to the rule that all optically active substances give piezoelectric crystals. —Ernest **Esclangon**: Zones of silence and their relation with meteorological characters.—Henri **George** and Edmond **Bayle**: Spectrophotometric definition of the colours of fluorescence.—Max **Morand**: New spectra emitted by a neutral atom of lithium.—M. **Pauthenier**: The isotropic augmentation of the index of liquids in the electric field. Results of experiments are given proving the existence of electrostriction, equivalent to a condensation of the liquid in the uniform electric field. This phenomenon has no relation with double refraction.—Thomas Martin **Lowry** and Percy Corlett **Austin**: The origin of the anomalies of the rotatory dispersion of tartaric acid.—P. **Lecomte du Noüy**: The dimensions of the molecules and the molecular weights of the proteins of serum. Assuming that the monomolecular layer corresponds to the minimum surface tension, and that Millikan's Avogadro number is $N = 6 \cdot 2 \times 10^{-23}$, the molecular weight of albumen is 36,600 and of the globulins 35,000.—Paul **Pascal**: The filiation of the polymetaphosphates.—F. **Bourion** and E. **Rouyer**: A kinetic anomaly observed in the reduction of mercuric chloride by sodium formate.—Fran. **Tucan**: The kämmercrite of the Jugoslavian chromites.—Ch. **Mauguin**: The arrangement of the atoms in the crystals of calomel. An account of results obtained by the X-ray method, which support the view that the molecule is Hg_2Cl_2.—Pierre **Bonnet**: The existence of the Darian and the lower Eocene in southern Transcaucasia: limit between the Secondary and the Tertiary.—Rene **Souèges**: Embryogeny of the Rubiaceæ. Development of the embryo in *Sherardia arvensis*.—Charles **Richet**, jun.: The action of formates on the growth of certain plants cultivated in pots.—Marcel **Baudouin**: The utilisation of an optical illusion of photographic order for the study of the prehistoric rock sculptures.—Harry **Plotz** and M. **Schoen**: Some observations on the changes of the reaction of serums. Horse serum exposed to the air at 37° slowly increases in alkalinity, from initial $P_H = 7 \cdot 25$ to $8 \cdot 72$ after 8 days. In sealed tubes the change is in the opposite direction.—Edouard **Chatton** and André **Lwoff**: The evolution of the infusoria of Lamellibranchs: comparative morphology of the Hypocomideæ. The new genera Hypocomina and Hypocomella.

CAPE TOWN.

Royal Society of South Africa, April 16.—Dr. A. Ogg, president, in the chair.—V. **Vermooten**: The long bones of the South African Bushman. The whole arm of the Bushman is relatively shorter, and therefore less simian, than the arm of the Negro or European, and it is a degree shorter still in the Bushwoman. The radius, on the other hand, is relatively longer than that of the European, and therefore more simian, but it is not so long as that of the Negro. The tibia is relatively long, and the humerus is relatively short.—C. **von Bonde**: Note on the Heterosomata of Portuguese East Africa. The collection comprises twenty species belonging to 16 different genera. One species, *Pardachirus marmoratus* (Lacépède), is of particular interest, having been described before only from the Red Sea and Madagascar. It has now been obtained from Delagoa Bay. Two new species, *Samaris delagoensis* and *Cynoglossus hunteri*, are here described for the first time. In their distribution the Heterosomata of Portuguese East Africa are closely related to those of Natal waters, and some few species recently described from Natal have now been found in this region.

Official Publications Received.

Commercial Intelligence Department, India. Agricultural Statistics of India, 1921–22. Vol. 1: Area, Classification of Area, Area under Irrigation, Area under Crops, Live-Stock, Land Revenue Assessment, and Harvest Prices in British India. Pp. ix+99. (Calcutta: Government Printing Office.) 1.2 rupees.

British Legion: Officers' Benevolent Department. Fourth Annual Reports and Accounts, for the Year ending 31st December, 1923. Pp. 31. (London: 48 Grosvenor Square, W.1.)

Journal and Proceedings of the Sydney Technical College Chemical Society for 1922. Vol. 1. Pp. 88. (Sydney: Alfred J. Kent.)

Imperial Department of Agriculture for the West Indies. Report on the Agricultural Department, Tortola, 1921–22 and 1922–23. Pp. iv+30. (Barbados.) 6*d.*

Agricultural Census of the Colony and Protectorate of Kenya, 1922. Third Annual Report. Pp. 17+tables and charts. (Nairobi: Department of Agriculture.)

Bulletin of the National Research Council. Vol. 7, Part 5, No. 41: Transactions of the American Geophysical Union, Fourth Annual Meeting, April 1923, Washington, D.C. Pp. 150. Vol. 8, Part 1, No. 43: Proceedings of the Third Annual Meeting of the Advisory Board on Highway Research, Division of Engineering, National Research Council. Edited by William Kendrick Hatt and E. R. Olbrich. Pp. 162. Washington, D.C.: National Academy of Sciences.) 2 dollars each.

Public Library, Museum, and Art Gallery of South Australia. Records of the South Australian Museum, Vol. 2, No. 4. Pp. 459-560+plates 23-39. (Adelaide.) 10*s.* 6*d.*

Ministry of Public Works, Egypt: Physical Department. Meteorological Report for the Year 1919. Pp. xiii+138. (Cairo: Government Publications Office.) P.T. 30.

Conseil Permanent International pour l'Exploration de la Mer. Bulletin statistique des pêches maritimes des Pays du Nord de l'Europe. Vol. 11, pour les années 1919–1920. Rédigé par D'Arcy Wentworth Thompson. Pp. 137. (Copenhague: A. F. Høst et fils.)

The North of Scotland College of Agriculture. Guide to Experiments at Craibstone, 1924. Pp. 64. (Aberdeen.)

Transactions and Proceedings of the Royal Society of South Australia. Vol. 47. Edited by Prof. Walter Howchin; assisted by Arthur M. Lee. Pp. iv+442+36 plates. (Adelaide.) 21*s.*

Proceedings of the London Mathematical Society. Second Series. Vol. 22. Pp. 1+512. (London: Francis Hodgson.)

Proceedings of the Cambridge Philosophical Society. Biological Sciences, Vol. 1, No. 2. Pp. 63-137+5 plates. (Cambridge.) 12*s.* 6*d.*

University of Bristol. Proceedings of the Spelæological Society, 1922–1923. Vol. 2, No. 1. Pp. 88+5 plates. (Bristol.) 2*s.* 6*d.*

Diary of Societies.

SATURDAY, JUNE 28.

ROYAL SOCIETY OF MEDICINE (Combined Meeting of Laryngology and Otology Sections), at 10 A.M.

MONDAY, JUNE 30.

WORLD POWER CONFERENCE (at British Empire Exhibition). (Also on July 1 to 12.)

WEDNESDAY, JULY 2.

ROYAL SOCIETY OF MEDICINE, at 5.—Annual General Meeting.

THURSDAY, JULY 3.

INSTITUTION OF CIVIL ENGINEERS (Joint Meeting with Institution of Mechanical Engineers, Institution of Electrical Engineers, Institution of Naval Architects, Institute of Marine Engineers, North-East Coast Institution of Engineers and Shipbuilders, Institution of Engineers and Shipbuilders in Scotland, Institute of Chemistry of Great Britain and Ireland, Institution of Gas Engineers, British Electrical and Allied Manufacturers' Association, British Engineers' Association, which are co-operating in the work of the Special Committee on Tabulating the Results of Heat-Engine and Boiler Trials), at 5.—Capt. H. Riall Sankey: The General Scope and Objects of the Work of the Committee. (The Paper will be followed by a general discussion on debatable points.)

SATURDAY, JULY 5.

THE INSTITUTION OF MECHANICAL ENGINEERS (Joint Meeting with the Institution of Civil Engineers), at 11.30.—Draft Standard Test Code for Hydraulic Power Plants, drawn up by a Joint Committee of the Institutions of Civil and Mechanical Engineers.

RÖNTGEN SOCIETY AND THE ELECTRO-THERAPEUTICS SECTION OF THE ROYAL SOCIETY OF MEDICINE (Joint Meeting at the Radcliffe Infirmary, Oxford), at 3.30.—Sir Thomas Horder: The Influence of Radiology upon the Criteria of Disease (the Mackenzie Davidson Memorial Lecture).—Prof. S. Russ: Experimental Studies upon the Lethal Dose of X-rays and Radium for Animal Tumours.

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Official Publications Received.

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... Meeting in the Radcliffe Infirmary ... The Advance of Radiology ...

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