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Research and Education in Agriculture.

IT is difficult for the lay mind to appreciate the possibilities of an architectural venture until at last the scaffolds are withdrawn and the finished building stands forth for all to see—to praise or to blame. It has been thus with the steady building up of our present system of agricultural research and education. It is only now, as the scaffolds are being slowly removed, that we can realise to the full the scope of the edifice which it has been sought to erect.

The Report recently issued by the Intelligence Department of the Ministry of Agriculture [1] is an interesting document, in which it has been possible perhaps for the first time to give the reader a complete picture of the machinery by which it is hoped to bring scientific knowledge and scientific method to the direct aid of the farmer. It will be a matter of surprise to many—no doubt accustomed to think that England still lags far behind other countries in the matter of financial support to agricultural research and education—to find on what a substantial foundation the system has been built. The plans, too, have been well drawn, for they allow of harmonious expansion in several directions, and there can be no gainsaying that the system as a whole holds much promise for the future.

It will be apparent that one of the corner-stones of the whole structure is research—and it is satisfactory to be able, in parenthesis, to add that the farmers themselves have been second to none in their anxiety that this stone should be well and truly laid. Not only are annual grants to a total exceeding 104,000*l.* made to twenty-one research institutions in England and Wales—each charged with definite lines of inquiry—but also grants now amounting to 31,400*l.* are made to fourteen advisory centres in order largely to provide for research into purely local problems.

It is very satisfactory to note that the advisory system has been considerably strengthened—the grants have been increased by 13,650*l.* since 1921–22, and advisory economists have now been appointed to the majority of the centres. Perhaps the chief merit of the advisory scheme is the tacit recognition of the importance of stimulating the research spirit in connexion with the teaching departments. It follows that a far-reaching effect of the strengthening of the personnel at the colleges consequent on the appointment of the advisory officers is that the teaching staff have greater opportunities for specialisation and for conducting independent research.

Grants to agricultural departments of the universities and to agricultural colleges for higher education

[1] Ministry of Agriculture and Fisheries. Report of the Work of the Intelligence Department of the Ministry for the three years 1921–24. Pp. 163. (London: H.M. Stationery Office.) 5*s.* net.

are made to fifteen institutions to a total of 48,500*l.* There is less disparity between the grants made to the different teaching centres—although even here it is appreciable—than to institutions charged primarily with research. In the latter case a large disparity is almost inevitable, since the several research institutions have very different terms of reference demanding very different staffing and equipment. As time goes on it is, however, to be hoped that it will be found possible rather to level up the grants to the several institutions than to accentuate the differences further—and this tendency should be applied alike to research and educational grants. Over-wide disparities in the distribution of public funds are at all times undesirable, and if carried to excess might possibly stimulate something much less desirable than healthy rivalry.

Grants to the counties have totalled 150,000*l.*, making the gross expenditure on county work, in part financed from local funds, 224,000*l.* Agricultural organisers are now attached to practically all the counties in England and Wales, while in a large number of counties there also exists the nucleus of a sound educational staff. The provision of farm institutes in the counties has been increased to fourteen.

There is thus provided a complete chain from research to education aiming at bringing the maximum of assistance to the farmer. The organisation of the whole system, however, presents difficulties, for not only are a large number and wide range of workers involved, but administration also falls to a number of different bodies — the Ministry of Agriculture, the governing bodies of colleges, universities and research institutions, and the county authorities. In regard to some aspects of the work responsibility is also, in part at least, delegated to advisory committees or councils, while trade interests and opinions have frequently to be considered.

The Ministry of Agriculture has sought to coordinate the whole work by setting up standing conferences, such as, for example, those of the advisory pathologists and advisory chemists, and from time to time calling larger conferences of research, college, and county workers. Regional conferences of all the workers in the counties associated with the different advisory centres have also become general, and more and more are fulfilling the most important part in the smooth working of the machine. There is perhaps real risk, however, that some of the measures adopted may tend towards a too great standardisation in respect of the functions and duties of both institutions and individuals, rather than towards co-ordination in the highest sense.

In research a certain amount of overlapping can never be avoided, and since method and individuality go for so much, is perhaps rather to be encouraged than the reverse. The consequences could only be disastrous if research came to be considered as almost the sole prerogative of the research institutions and of the advisers, and if the drawing up, or criticism, of schemes of research or inquiry were deemed only to be the concern of the "official" research workers. In a loosely knit together system the success of which depends solely on good-will—and since the system is primarily intended to serve the interests of a profoundly complicated industry—the ideas of practical workers in close touch with the farmer should be regarded as of at least equal value in formulating profitable lines of research to those of the research workers themselves.

It is, therefore, of the utmost importance that the constitution of all conferences and committees—if only remotely connected with the administration of any part of the scheme—should always be such as to imply nothing in the nature of prerogatives. Moreover, the terms of reference under which an institution or an individual worker acts, no matter how restricted their scope, are surely not intended to imply the possession of a monopoly; consequently—and in order to dispel completely the possibility of any such views being held—the greatest possible encouragement should be given to any independent worker of proved capacity to proceed with an attack by methods which seem good to him on a problem to which he is attracted, even if the investigation comes within the category of subjects dealt with at one of the research institutions. Any tendency in the opposite direction should be rigidly guarded against, for if allowed to develop it would assuredly shatter the stability of the whole fabric, and would certainly tend to stultify originality, which is the life-blood of successful investigation.

There is very considerable evidence in the report to show that scientific information is, in fact, not only being put into the farmers' hands, but is also being used to good advantage. Perhaps the most significant figure quoted in this connexion is that 6782 persons attended evening classes during the year 1923–24, while the success of the formation of agricultural discussion societies in the counties is another excellent augury for the future. The value of these classes and societies will, moreover, increase in proportion as the number of young men with practical farming as their objective pass through the colleges and farm institutes.

The various schemes of organisation pressed forward by the Ministry have amply justified themselves. This is well seen with reference to the recent great advances made in poultry keeping in Great Britain and in relation to various aspects of the horticultural industry. In some ways the most significant work of organisation is that connected with certain features of the administration of the Destructive Insects and Pests Act. Reference is made to the inspection and certification of growing crops of approved immune varieties of potatoes and to the wart disease immunity trials conducted under the auspices of the National Institute of Agricultural Botany at its Ormskirk station. These constitute relatively new departures, which eventually will almost certainly be applied in principle to other crops with beneficial results of a magnitude that at present we can but dimly foresee.

By no means the least important of the activities under the general guidance of the Ministry are the various live-stock improvement schemes. The report before us is evidence in particular of the fruitful results of the comparatively recently introduced milk-recording scheme. The recorded herds show a substantial increase in the average yields per cow from year to year, and, what is of greater importance, a marked improvement in the proportion of high-yielding cows in the several herds, due to the steady weeding out of the poorer milkers. This is a scheme which has an altogether greater value than is indicated merely by the convincing statistics given—for more than any other educational activity it has taught the farmer the value of accurate records, a lesson which he must come eventually to apply to all his breeding and perhaps to most of his practices.

From the scientific point of view, the achievements have important implications, for they show the necessity of testing and checking the validity of show-yard criteria in respect of all live-stock. At present the breeding societies, assisted by the Ministry, base the selection of sires almost wholly on show-yard criteria, and the excellence of the selections made is sought to be substantiated in a paragraph—which is perhaps prematurely thrasonical—alluding to the successes of stock by premium bulls at the shows.

The whole question of the merits of one breed compared to another, and of one type of animal within the breed to another, is intimately connected, however, with economy of conversion of feeding-stuffs. It would perhaps be wise, in view of the teaching of the milk records, to initiate well-planned local schemes of experimentation, at carefully selected centres, designed to obtain trustworthy data on the economic suitability of different types of animals for the different conditions obtaining. This should be done before going too far to encourage breed societies run on the unproven assumption that show-yard criteria afford the correct basis for selecting sires competent to beget progeny with the highest possible money-earning capacity when employed as ordinary farm stock in the districts severally served by the societies.

The History of Engineering.

A History of Engineering. By A. P. M. Fleming and H. J. Brocklehurst. (The Histories of English Industries Series.) Pp. vii+312. (London: A. and C. Black, Ltd., 1925.) 12*s.* 6*d.* net.

THOUGH there are many biographies of engineers and historical works in various branches of engineering, no attempt appears to have been made to write a general history of engineering. The reasons for this are perhaps not far to seek. No one but an engineer could write such a book, and engineers, as a rule, are actively engaged in the exercise of their profession and are concerned more with the present and the future than with the past. It is true many engineers possess the necessary literary ability and a few the wide knowledge and experience, but the opportunities for historical studies are but few. A step in the right direction was taken a few years ago when the Newcomen Society was founded, and the researches by its members will prove a mine of information for the future historian. But the subject is a vast one; the materials are there in profusion, and the task of selection is by no means easy. Of the sources of information, none are perhaps of more value than the transactions of the various engineering societies, the addresses of the presidents often containing historical reviews of great importance; those of Sir John Rennie in 1846 and of Sir William White in 1903 to the Institution of Civil Engineers being two notable examples.

While no general history of engineering exists, historical notes are often given in text-books, and there is ample evidence that in the profession there is a growing sense of the value of the records of the past. France and England have possessed museums illustrating invention and engineering for many years, German engineers supported whole-heartedly the building up of the Deutsches Museum in Munich, and energetic action is now being taken to form a National Museum of Engineering and Industry for the United States. This will probably take the form of a central museum at Washington, with smaller museums of an educational character in some of the great industrial centres. This is a movement which will be watched with growing interest. The committee entrusted with the task of inaugurating the American Museum includes representatives of the four Founder Societies of Civil Engineers, Mechanical Engineers, Mining Engineers, and Electrical Engineers. For their president they have Mr. Samuel Insull, of whom it has been said "no ship ever stranded which had him for its helmsman."

Nearly all engineering can be included in four groups relating to transport, communication, power, and production. The story begins with the earliest of tools, the making of sledges and the use of metals. It includes the construction of canals and harbours, bridges and aqueducts by the Chinese, the Egyptians, and the Romans, who, working with the simplest appliances, raised those monumental works which claim our profound admiration to-day. While admitting the absorbing interest of the study of the engineering feats of the ancients, it is modern engineering which has changed the face of the world and the habits of nations. Modern engineering had its birth with the steam engine in the early part of the eighteenth century, and its scope is indicated by the definition accepted after much deliberation by the American Society of Mechanical Engineers in the statement: "Engineering is the science of controlling the forces and utilising the materials of nature for the benefit of man and is the art of directing and organising human activities in connexion therewith." The definition breathes a spirit of service worthy of the noble heritage of the engineer; a heritage of which we cannot know too much. Each generation has produced its pioneers, and the young engineer will find in their lives a source of inspiration. The objects of our engineering museums include the preservation of historic works, but they might also well include the publication of adequate and impartial histories of the progress of engineering.

Like all science, engineering is international, and the improvements and discoveries of each nation are available for all. Yet there is room for the histories of nations as well as of mankind, and the book which has led to these remarks is a history of engineering devoted mainly to the story of engineering in England. It has chapters on docks and harbours, canals, roads and bridges, steam, railways, iron, gas and electricity, as well as a short chapter on ancient engineering. The writers, however, have mainly kept to the old well-beaten tracks, and we are thus once again brought into the company of Brindley, Newcomen, Stephenson, Cort, Watt, Hedley, and Faraday. The story retold is of immense importance, but we should have been glad of more information regarding the growth of the great industries these pioneers promoted. Of thirty-four pages given to the chapter "The Age of Steam," thirty are devoted to Savery, Newcomen, Watt, and their contemporaries, and four to the steam turbine. We nowhere find the names of Perkins, Donkin, Hicks, Joule, Marshall, Elder, Kirk, Rankine, Willans, or Yarrow. The compound and triple expansion engines, the high-speed engines working with high pressures, were all very important improvements, and half a century ago numerous engineering firms were employed almost solely in their production. We were the makers of steam engines for the whole world, and the history of this industry has never been written.

As introductory essays to the study of engineering history, the sketches in the book are well worth reading, but much more is required than this. The sense of proportion is one of the essential qualifications of the historian of engineering if he is to endeavour to follow in the footsteps of Gibbon, who with a wide and intimate knowledge of his subject possessed the power of mastering his materials and of condensing them into a broad and well-filled narrative in a manner which has never been surpassed. We speak of the age of steam, the iron age, the steel age, the age of machinery, the age of electricity, and the age of invention, but there are no such separate ages; they are all included in the age of modern engineering, and the telling of that story still awaits its Gibbon.

The Psychology of Juvenile Crime.

The Young Delinquent. By Prof. Cyril Burt. Pp. xx+643. (London: University of London Press, Ltd., 1925.) 17*s.* 6*d.* net.

PROF. BURT'S aim in this important study is primarily practical; he wishes to afford to teachers, probation officers, and others, aid in the investigation and treatment of young offenders. His practical advice, however, is based upon an exact and scientific study of data collected by himself in the course of his work in connexion with the schools of the London County Council, and he brings to bear upon the treatment of his problems a breadth of outlook very rare in the previous studies of the etiology of crime. Very frequently these have been vitiated by over-emphasis of selected cases, by preconceived notions as to the relative importance of heredity and environment as determinants of human conduct, by the absence of a sound anthropological and psychological basis.

Prof. Burt's work undoubtedly avoids these defects. His method is to take a sample collection of two hundred consecutive cases of juvenile delinquency, to study these intensively, and to check his conclusions by a study of a control group of four hundred cases taken from the non-delinquent population of children of the same age and social class, living in the same streets and attending the same schools. In each case he studies carefully the home circumstances, the family history, the physical and mental condition of the child concerned. His main conclusions may be briefly indicated. As to hereditary factors, he shows that the notion that crime can be as such inherited is due to crude and antiquated ideas as to the existence of an innate moral sense, and to the fact that most writers on the subject have adopted the method of citing conspicuous case histories and selected family trees with crime occurring in all of them. His own elaborate statistical study shows that cases of sporadic crime are far more usual than those with criminal lineage. It is true that intellectual and moral defects have a high frequency among delinquent families, but the figures given approach closely those for defective discipline and vicious surroundings, and it is therefore possible that we are dealing rather with contagion than biological heredity. We shall see later that a direct hereditary relation is asserted of crimes based upon an exaggeration of certain instincts. But even in these cases the instincts underlying them are not as such criminal and are never the sole causes of the crimes committed. All that can be said at the most is that what is inherited is a vague congenital enfeeblement which may affect the temperament, intelligence, and physique as a whole, and may in certain circumstances find expression in tendencies to crime.

It is one of the many merits of Prof. Burt's work that he avoids any undue separation between environmental and hereditary factors. It is not any given situation or environment that makes a man a criminal, nor is crime due to hereditary structure or equipment taken in itself. In all cases we have to deal with a subtle and intricate personal response to a given situation. Such response is never merely mechanical, never a passive effect of an external cause, but the active expression of the mind of the individual in relation to his environment. It is necessary, accordingly, to study both the innate equipment and the environmental condition of the criminal, but the two sets of factors must not be sharply separated from one another and pitted against one another in the simple manner so common in the literature of the subject. Moreover, in regard to the environmental factors, it must be remembered that owing to their complexity they can scarcely ever be fully and adequately determined, and that though, for purposes of investigation, each factor may be studied in abstraction from the rest, yet in fact they interact and modify one another in the most intricate and perplexing manner.

The use of mathematical or statistical expressions often gives to results of social inquiry an appearance of precision quite unwarranted by the crude data upon which they are commonly based. Prof. Burt uses his statistical methods with the caution which we have learnt to expect from him. The coefficients of association he arrives at for environmental factors are: for poverty, 0·15; for defective family relationships, 0·33; for vicious homes, 0·39; for defective discipline, 0·55; for conditions outside the home, including unemployment, uncongenial work, influence of associates, 0·29. He shows clearly that the commonest and most disastrous conditions are those that centre about the family life. As regards physical characteristics, Prof. Burt confirms the conclusion, reached by Goring in relation to adults, that the criminal conforms to no definite physical type. On the other hand, defects of development and general physique are more common among delinquent than among non-delinquent children of the same class. In general intelligence delinquent children have a lower average mental ratio than the non-delinquent. More serious is the fact that the "educational ratio" of the former which measures their attainment as distinguished from their ability is only 81 per cent., that is, at the age of ten their attainments are on an average those of a child of eight, and that of those who have left school, more than half are under the level of Standard V.

The least satisfactory portion of the book seems to me to be that devoted to the study of the temperamental conditions of crime. Prof. Burt finds a correspondence between categories of delinquencies and the usually accepted classifications of instincts, and this leads him to stress the instinctive origin of certain types of crime, especially those connected with sex, violent temper, wandering, and impulsive theft. But there is, as I think, at present too much divergence of opinion both as to the nature and classification of human instincts to make such a treatment really fruitful. Some examples will make this point clear. Prof. Burt studies cases of theft in connexion with the instinct of acquisition, but it may be and has been seriously doubted whether acquisition in man is really instinctive. The processes of acquiring are generally connected with the satisfaction of other instincts, for example, nutrition and sex, and objects connected with these and other instincts may by well-known psychological processes of assimilation and acquirement of meaning come to have value attached to them. Cases of so-called "objectless" hoarding can generally be shown by analysis to have an interest real enough to the subject concerned, though meaningless to the external observer.

So again, I doubt whether self-assertiveness and self-submission can be correctly spoken of as instincts. They seem to indicate rather degrees of strength with which the instincts generally express themselves in different individuals. If this be so, the explanation of cruelty given by Prof. Burt as due to an exaggeration of the instinct of assertiveness is only true in the sense that the intensification of any instinct, notably of combativeness and sex, may lead to a condition of absorption causing disregard of the pain of others. Again, to assert that sex-differences in relation to crime are connected with the different strengths of the instincts in the two sexes seems, in the present state of the psychology of the instincts, weak methodologically. For example, the explanation suggested on these lines of the greater frequency of cases of theft among boys than among girls, would have been better grounded if Prof. Burt had been able to produce independent evidence to show that women are innately less acquisitive than men. One conclusion certainly emerges from this discussion, namely, the urgent need there is at present for a really scientific classification of the human instincts. The volume before us is the first of a series of three. The other two will be eagerly awaited by all students of social science and education. MORRIS GINSBERG.

The Structure of the Earth.

Der Aufbau der Erde. Von Dr. B. Gutenberg. Pp. viii+168. (Berlin: Gebrüder Borntraeger, 1925.) 9 gold marks.

THE work under review is a general survey of the known results relating to the condition of the interior of the earth. In most cases the theories discussed are not developed in detail, but summaries of the data and the main conclusions are given. Accordingly a very large amount of material has been compressed into a small space. It may be said that the main use of the book is to facilitate reference to original investigations; in this the reviewer speaks from his own experience. Perhaps the greatest difficulty that besets geophysics is that its literature is scattered through so many periodicals. It is easy to think of eight British journals that have contained important geophysical (apart from meteorological) papers during the past ten years, but in Germany the confusion is even greater. The bibliography in this book refers to twenty papers by the author himself, in nine periodical and several non-periodical publications; and the total number of German periodicals including geophysical papers is such that some convenient summary, with references, such as Dr. Gutenberg's book affords, is essential to any one wishing to know what work has actually been carried out. Unfortunately there are signs of insufficient verification; near the beginning of the bibliography we find "Cooker" for "Coker," without indication that the associated Adams is F. D. and not J. C. or L. H.; and incorrect initials are then attributed several times to L. H. Adams. But the labour involved in compiling a 14-page bibliography in the circumstances must have been enormous, and the author deserves our gratitude, especially as he has done justice to countries and languages not his own.

The seismological parts of the book merit the greatest attention. The illustrations on pp. 7, 8, 25, 30, and 96, showing typical seismograms for various epicentral distances, are a valuable feature. Accounts are given of the determination of the wave-velocities at various depths from the times of transmission, and also of Zöppritz's method of amplitudes, the actual application of which is largely due to Dr. Gutenberg. If the velocity of a compressional wave, say, increases steadily with depth, the amplitude of the motion it produces on emerging at the surface will vary smoothly with distance from the origin; but if the rate of increase of the velocity with depth changes suddenly, the amplitude will also change suddenly. As a rule, observations of the same shock at many stations are not collected, and use was made, instead, of the ratios of the amplitudes of the primary and first reflected waves for different earthquakes; this plan has obvious drawbacks, but it has the advantage that all the observations were made on the same instrument. The method is very sensitive, and its use probably lies mainly in filling in the finer details of the variation of velocity, the times of transmission giving the general outline. A rather sudden decrease of the velocity of the compressional waves, at a depth of about 0·6 of the radius, was inferred from the time-curves by R. D. Oldham in 1906. Gutenberg shows that this is confirmed by the smallness of these waves for distances of 110°-140°, while their reappearance at minimum deviation is indicated by the large amplitudes found at about 140°. That the central core below this depth is truly fluid is indicated by the absence of distortional waves at greater distances.

An account is given of the "individual P-waves" of A. and S. Mohorovičić—compressional waves from foci within the outer granitic layer, which travel directly from the focus to the surface, whereas the normal P-wave travels down to the basic rocks below and up again. These and explosion waves give valuable information about the surface layer, and the author then discusses the surface waves at length. The estimate of the thickness of the surface layer based on these last is, however, vitiated by a confusion between wave-velocity and group-velocity.

Other chapters deal with the figure of the earth, the internal distribution of density, chemical composition, the cooling of the earth, and the structure of the atmosphere. The age of the earth and tidal friction are not discussed, but the bodily tide is considered at some length. The author has misunderstood the situation with regard to the explanation of the annual variation of latitude, for he suggests that the work of the present reviewer on this subject was an attempt to improve on that of Schweydar, which was already perfect. Actually my work was published in 1916, Schweydar's in 1919 (of course, independently), and in both there remains a considerable discrepancy between theory and observation.

Dr. Gutenberg's book is an important contribution to geophysics, both for its own content and for the aid it gives in the search for other literature.

H. JEFFREYS.

Our Bookshelf.

The Dinoflagellates of Northern Seas. By Dr. Marie C. Lebour. Pp. vii + 250 (35 plates). (Plymouth: Marine Biological Laboratory; London: Dulau and Co., Ltd., 1925.) 12*s.* 6*d.* net.

A SHORT account is given of the general morphology of the Dinoflagellata, in which the terms afterwards employed are clearly explained, the various modes of nutrition are considered, and notes are added on the reproduction and habits. Dr. Lebour expresses the opinion that a large proportion of what are now regarded as species may prove to be merely phases in the life-history of other species. An outline classification showing the families and genera precedes the systematic account, in which a short description of each genus and species is given, and the characters of the species are illustrated by one or more line drawings—those on the 35 plates being original. The methods of collecting and examining dinoflagellates are briefly described, a list of memoirs on the sub-class is appended, and there is a full index.

Dr. Lebour set herself the task of making as complete a survey as possible of the dinoflagellates which are known to occur in northern seas, and she has accomplished the work in a highly successful and critical manner. Her memoir will be warmly received by all who are interested in these organisms.

Kelvin the Man. A Biographical Sketch by his Niece, Agnes Gardner King. Pp. xv + 142 + 12 plates. (London: Hodder and Stoughton, Ltd., 1925.) 7*s.* 6*d.* net.

BY the many admirers of Lord Kelvin this book will be welcomed. In 1910, Silvanus Thompson wrote the official biography. In the preceding year, Kelvin's sister, Mrs. King, wrote "Lord Kelvin's Early Home," which gives a delightful picture of him from childhood to adolescence as a member of a singularly gifted and harmonious family. Silvanus Thompson says that he purposely abstained from trenching on that narrative, which brings the story of Lord Kelvin's life to 1849. The gap in the story of his personal and family life from 1849 onwards is now filled up by this book written by his niece, Agnes Gardner King. She presents a very pleasant home picture of the great physicist, showing a very human and lovable side of his character. In the introduction, Sir Donald MacAlister says: "The testimony of an eye-witness in intimate touch with his home, and capable of putting down in simple and vivid words what she saw and heard, will crown as with a garland of home-grown flowers the Centenary Memorial raised to his scientific fame."

Intermediate Light. By Dr. R. A. Houstoun. Pp. x + 228. (London: Longmans, Green and Co., 1925.) 6*s.*

ENCOURAGED by the favour shown by advanced students to his "Treatise on Light," Dr. Houstoun has now produced an elementary book on the same subject. It is broadly of University Intermediate or Higher Certificate standard, but the author, it is pleasant to note, is at no pains to conform to the syllabus of any particular examination. The book, therefore, contains matter seldom found in the ordinary elementary text-book. Colour and colour vision, for example, claim more space than is customary, and the historical references are both less meagre and less stereotyped than usual. At the same time, examination requirements are by no means overlooked, and a collection of questions from various public examinations forms a useful appendix. Other noteworthy features are the numerous and well-planned practical exercises and the new illustrations of familiar principles which are selected whenever possible. The diagrams and production are excellent; in fact, we have noticed nothing more reprehensible than a split infinitive. There is no doubt that the book deserves and will enjoy a wide popularity.

Prof. Dr. Paul Pfurtscheller's Coloured Zoological Wall-Plates. Plate 32: The Common Gnat (*Culex pipiens*). Insecta, Diptera II. 4 ft. 8 in. × 4 ft. 3 in. (London: W. and G. Foyle, Ltd.; The Hague: Martinus Nijhoff, 1925.) Unmounted, 10*s.* 6*d.*; mounted, with rollers, 16*s.*; mounted, with rollers, varnished, 17*s.* 6*d.*

THIS is an excellent plate, lithographed in colours, illustrating the external features of the larva (from the dorsal aspect) and the pupa and the female winged gnat (as seen from one side). The important features are clearly displayed, the parts being skilfully arranged so as to exhibit as much as possible. A portion of the wall of the abdomen of the imago is shown cut away to permit representation of parts of the stomach, intestine, Malpighian tubes and ovary. In the fourth figure the head of a female and the mouth parts are drawn on a larger scale. It is ungracious to ask for more on such a full plate, but a drawing of the head of a male would have been helpful for comparison with that of the female.

Bacteriology. By Prof. Carl H. Browning. (Home University Library of Modern Knowledge.). Pp. 256. (London: Williams and Norgate, Ltd.; New York: Henry Holt and Co., 1925.) 2*s.* 6*d.* net.

WE think that Prof. Carl Browning has been extraordinarily successful in presenting a general outline of the principal facts concerning bacteria in a simple and concise manner suited to the general reader. The whole range of bacteriology is dealt with—history, the microscope, methods of investigating bacteria, and their rôle in Nature and in the causation of disease. Subjects such as antitoxins and the toxin-antitoxin reaction, complement fixation, the Weil-Felix agglutination reaction in typhus fever, ultra-microscopic organisms, the bacteriophage, immunity and chemotherapy, are all considered, and their presentation is such that any one reading the accounts of them will have a very good general idea of what they are and mean.

Geometry for Beginners, as far as the Theorem of Pythagoras. By J. G. Bradshaw. Pp. vii + 99. (London: Longmans, Green and Co., 1925.) 2*s.* 6*d.*

IN many respects an excellent little book, in which blank pages are left for the pupil to insert his own proofs of the simpler propositions which are treated as riders. It is not in accordance with modern views, however, that beginners should be asked to learn the time-honoured proofs for congruence and parallels.

Letters to the Editor.

The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*]

Further Studies of Sun-fishes made during the *Dana* Expedition, 1921-1922.

IN the columns of NATURE for March 17, 1921, I gave an account of the development of the sun-fishes so far as it was known up to that date, based on the investigations made during the first *Dana* expedition, in the course of which I was able to study the larvæ in a living state.

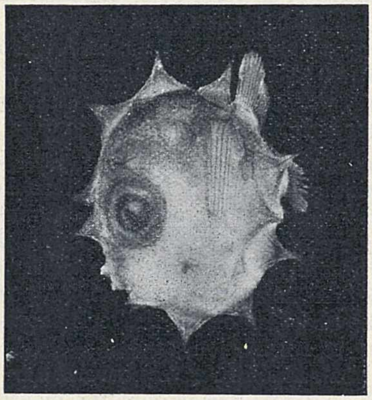

FIG. 1.—*Mola rotunda*, the short sun-fish. Specimen 5 mm. in length (*Dana*, St. 1238, 26° 13′ N., 78° 48′ W.).

The article described briefly the development of the two species, *Ranzania truncata* (the oblong sun-fish) and *Mola lanceolata* (the pointed-tailed sun-fish).

In a later and more detailed work, published by the Danish Commission for Investigation of the Sea ("Meddelelser fra Kommissionen for Havundersø-gelser," Serie Fiskeri, vol. 6, No. 6, Copenhagen, 1921) I gave a further account of the development, and showed also that there are in the North Atlantic area *three* species of sun-fish: namely, in addition to the little Ranzania, not *one*, but *two* species of the large sun-fish proper (Mola), these being the ordinary tailless *Mola rotunda* (the short sun-fish) and the rarer form, *Mola lanceolata* (the pointed-tailed sun-fish) with a short tail.

Only one of the sun-fishes is common in the vicinity of Europe and in the Mediterranean, namely, the short sun-fish (*Mola rotunda*), which attains a length of from 8 ft. to 10 ft. or more, and a weight of more than a ton. The oblong sun-fish (Ranzania) has occasionally been found near the shores of Europe, but *Mola lanceolata* has never yet been met with in these waters, and only once, by Prince Albert of Monaco, in the open sea near the Azores.

To judge from the number of adult specimens known, *Mola rotunda* must, therefore, be by far the commonest species, *Ranzania truncata* less common, and *Mola lanceolata* very rare.

The *Dana* expedition (1920–22), however, reveals an entirely different state of things as regards frequency of occurrence, so far as the early developmental stages are concerned.

On the first *Dana* expedition, in 1920, we found, in the Sargasso Sea, eggs and early stages in great numbers, chiefly those of Ranzania, but also many of *Mola lanceolata*.

These stages, described in the issue of NATURE above mentioned, were found in such abundance in the Sargasso Sea that there can be no doubt but that this sea is a very important breeding-ground for both species. Of *Mola rotunda*, on the other hand, we found not a single specimen in the early stages. Here, then, we encountered a phenomenon not unknown to the marine biologist, to wit, the fact that species which are "rare" in the adult forms may be "common" in the larval stages, and vice versa.

On the second *Dana* expedition, 1921–22, we found the same thing again; here, however, in addition to many early stages of Ranzania and of *Mola lanceolata*, we also obtained a single specimen of *Mola rotunda*, 5 mm. long. It is possible that there may be one or two more specimens in the material, but up to now this is the only known early representative of *Mola rotunda*, the commonest or best known of all sun-fishes, and is therefore of no slight interest.

It is shown in the accompanying illustration, Fig. 1, and together with a specimen of *Mola lanceolata* of equal size, in Fig. 2. The great difference in appearance of the two is noticeable at a glance, without going into details. *Mola rotunda*, for example, lacks the enormous development of some of those spines which are peculiar to the early stages of sun-fishes, while on the other hand, the so-called eye-spines are rather more strongly developed in *Mola rotunda* than in *Mola lanceolata*.

Another feature of interest should also be noted. The larvæ of *Mola lanceolata* were, as mentioned, common in the Sargasso Sea, whereas of *Mola rotunda*, not a single specimen was found here, despite the fact that the *Dana* expeditions fished very intensively in these waters.

The only known early stage of *Mola rotunda* was found in a region west of the Sargasso Sea, where the expedition worked to a very slight extent compared with our operations in the Sargasso Sea, namely, at St. 1238 (26° 13′ N., 78° 48′ W.), about 20 miles south of Grand Bahama Island. *Mola lanceolata*, on the other hand, was not found here, but was taken at the subsequent stations east of Bahama (*e.g.* St. 1240 at 25° 35′ N., 74° 45′ W.).

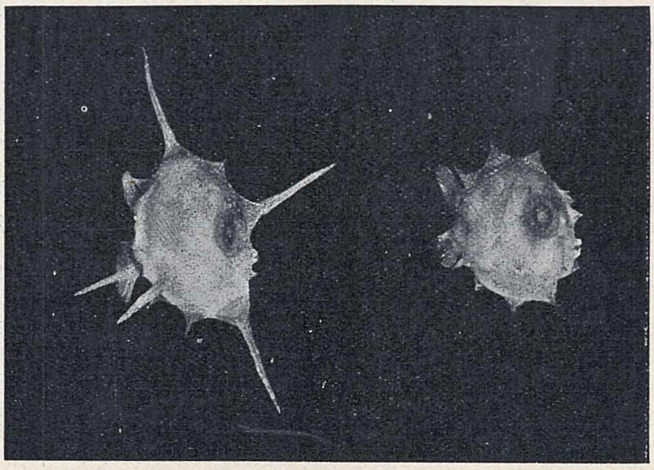

FIG. 2.—*Mola rotunda*, the short sun-fish, the same specimen as in Fig. 1, together with a specimen of the same size of the pointed-tailed sun-fish (*Mola lanceolata*), the latter from *Dana*, St. 1334, 27° 28′ N., 59° 29′ W.

So long as only a single specimen is known, it is of course impossible to say anything definite, but the question naturally suggests itself: May not the frequency of *Mola rotunda* as an adult form, in contrast to *Mola lanceolata*, on the shores of Europe, be primarily due to this very fact, that its spawning grounds lie farther west than the latter, rarer species, so that its larvæ would have more chance of being carried passively by the Gulf Stream and the Atlantic Current over to the European side?

I have to thank Mr. Å. V. Tåning for undertaking the difficult task of photographing the specimens shown, and also for valuable assistance in other ways.

JOHS. SCHMIDT.

Carlsberg Laboratory,
December 2.

The Energy Levels of the Nitrogen Molecule.

IN a paper before the American Physical Society (*Phys. Rev.*, 23, 294, Feb. 1924) and in a letter to NATURE (Nov. 1, 1924, vol. 114, p. 642), I gave a set of electronic energy levels for the neutral nitrogen molecule, based on an analysis of its band spectra. These levels were designated X, A, B, C, and D, where X denotes the stable state of the molecule. The interval X to A was suggested as 65,000ν (=8·0 volts), the band system corresponding to this transition being as yet unknown. Dr. Sponer (*Zeitsch. f. Phys.*, 34, 622, 1925), by measuring the excitation potentials of various groups of nitrogen bands, has now obtained results in exact agreement with this diagram. The X to A interval comes out as 7·9 volts.

Duncan (*Astrophysical Jour.*, 62, 145, 1925) also has measured excitation potentials in molecular nitrogen. In discussing the theory he has stated that the 0-0 band of the second group (λ3371) should be excited at a potential higher than the 0-0 band of the first group (λ9108) by 2·3 volts. This, however, is incorrect. The difference should be 3·66 volts, corresponding to the frequency of the 0-0 band of the second group. However, the bands of the first group which he *actually observed* should be excited at about 2·0 volts less potential than the 0-0 band of the second group, in agreement with his actual results (10 and 12 volts respectively). With this correction, and with the assumption that all of his measured potentials are about 1·3 volts too low, there is agreement between his results and those of Dr. Sponer, as well as with my theoretical diagram. The only measurement by Duncan in error by more than his stated probable error is that for the weak fourth positive group.

As a result of my analysis of the nitrogen levels, I further stated that the carrier of the characteristic afterglow bands of active nitrogen was a neutral nitrogen molecule with 11·5 volts of energy (9·3 volts electronic and 2·2 volts vibrational) in excess of the stable state. The afterglow phenomenon was noticed by E. P. Lewis and the chemical activity associated with the afterglow was discovered some ten years later by Lord Rayleigh, who gave the name "active nitrogen" (see NATURE, Nov. 15, 1924, vol. 114, p. 717). As has been customary, I identified the carriers of the afterglow bands with the entity responsible for this chemical activity, and hence was forced to postulate that this molecule with 11·5 volts excess energy was in a metastable condition. Because this condition corresponded to the high vibrational quantum number eleven, there are grave theoretical objections to such an assumption, and Dr. Sponer now assumes that "active nitrogen" is atomic nitrogen. The recent work of R. W. Wood, Bonhoeffer, and others, on atomic hydrogen, and of Franck and his co-workers on "collisions of the second class," now make such an assumption not only possible, but plausible, even though the afterglow (a secondary effect of the *association* of atomic nitrogen) has been obtained with a duration of more than fifteen minutes (R. Rudy, *American Physical Society*, Nov. 1925). The full argument is given in her paper, to which reference has just been made, and leads directly to the conclusion that the 11·5 volts of excess energy of the carriers of the afterglow bands measures accurately the heat of dissociation of nitrogen.

After the emission of the afterglow bands, the excited nitrogen molecule is in state A and has 9·4 to 8·9 volts of energy. The bands corresponding to the transition A to X should lie in a spectral region where Prof. Hopfield and I later found a system of bands (NATURE, July 4, 1925, vol. 116, p. 15), but this system gave progressions which, on the basis of the data then available, agreed with no other known progressions of nitrogen or of any other molecule. Using data which have recently become available, Dr. Sponer has now been able to classify this system, and her results are given in the accompanying letter.

RAYMOND T. BIRGE.

University of California,
December 5.

The Energy Levels of the Nitric Oxide Molecule.

IN a recent letter to NATURE (July 4, 1925, vol. 116, p. 15) R. T. Birge and J. J. Hopfield record the observation of a system of emission bands in nitrogen in the region of λ1854-λ1250. They found a formula for these bands that did not fit into the known level-scheme of nitrogen. This was a peculiar fact because the bands arising from the normal state of the N_2 molecule are to be expected in this region. The apparent discrepancy can now be explained by the discovery that these bands do not belong to the N_2 but to the NO molecule. This is quite possible, as the nitrogen used was not completely free from oxygen.

I am much indebted to Prof. J. J. Hopfield for giving me the opportunity to see the manuscript of an investigation by S. W. Leifson, on absorption spectra of different gases and vapours in the Schumann region (*Astrophysical Journal*, in press). By comparing the frequency differences of the NO bands of Leifson with those in the above-mentioned band-system of Birge and Hopfield, I find that both systems have a common state. The final state of the absorption NO bands of Leifson is also the final state of the emission bands of Birge and Hopfield. Moreover, with the aid of new wave-length measurements of certain bands of the third positive group of nitrogen, kindly made for me by Prof. Hopfield from his plates, I find that the absorption bands of Leifson are merely the 0-0, 0-1, 0-2, etc., bands of the third positive group. Leifson's plates contain also the Birge and Hopfield bands.

Hence we have conclusive evidence that the third positive group belongs to NO, as has usually been assumed, and that its initial state in absorption is the normal state of the NO molecule, as Mulliken (NATURE, Sept. 6, 1924, vol. 114, p. 349) and Birge (*ibid.*, Nov. 1, 1924, vol. 114, p. 642) had suggested. The excitation potentials of the levels of the NO molecule can be given from these considerations as 5·44 and 5·44 + 8·52 = 13·96 volts; that is, 5·44 volts for the excitation of the 0-0 band (λ2269) of the third positive group, and 13·96 volts for the excitation of the 0-0 band (λ1450) of the Birge and Hopfield bands. From this it follows that the ionisation potential of the NO molecule must be greater than 14 volts.

I am glad to have had the opportunity to discuss these matters with Prof. R. T. Birge, and wish to thank him for his friendly co-operation.

HERTHA SPONER.

University of California,
December 5.

The Study of Taxonomic Zoology.

THE proper study of any aspect of zoology involves the consideration of the following facts: (1) the external world, in contradistinction to the organism, is undergoing constant and ceaseless change; (2) the organism itself is similarly subjected to change; (3) the organism and its environment are in a constant state of reaction. The physical sciences aim at a correct understanding of what is happening in matter in its innumerable aspects and the reality underlying these changes. The biologist seeks to elucidate the phenomena connected with the organism, but his study is never thorough unless an attempt is made to correlate the relation of the changing organism to the external world. It is not possible to explain correctly the form, shape or function of a particular organ, or the behaviour of a particular organism and its relationships to other organisms, without taking into account the third consideration mentioned above, in other words, that every organism is trying to fit itself to live in its particular surroundings. This effort on the part of the organism is, to a large extent, conditioning its structure, its behaviour and its life-processes.

The primary object of taxonomy, or the systematic study of a group of animals, is to discover their relationships and to facilitate the advancement of this object by assigning to groups of individual kinds of organisms generic and specific names, grouped into more comprehensive sections such as families, orders, etc., according to the method instituted by Linnæus. Such names when first proposed must be accompanied by a description of the animal to which it applies, in which, so far as is possible, its relationships must be emphasised. It is assumed that the manifestation of relationship is resemblance, and in order to establish the affinities of one species with another they must be generally similar in structure, development, behaviour and habits. Practically, however, complete information about an organism is very often not available, and the systematist has therefore to make the best of the data at his disposal (which at present is for the most part morphological) in expressing an opinion on the affinities of the organisms he has studied. In doing so, he assumes further that the individuals showing these resemblances will breed true, and that no two such groups regarded as different will interbreed in Nature in ordinary circumstances. To this conception of closely allied, but different, groups of individuals the name "species" is given. In considering this concept of a species, it must be remembered that a general statement or "law" is true only within certain limits, and that the same organism will behave differently when these limits are exceeded and will acquire new properties and characteristics.

Resemblance presupposes differentiation. The recognition of resemblance follows from the true estimation of the value of differences in characters, and for the purpose of establishing relationships the proper estimation of this value is very important. The value of characters varies according to the group of animals dealt with, what is considered sufficient for establishing a species in one group being considered insufficient in another. The appreciation of this depends on the systematist's experience and on the extent to which data are available. In some groups (*e.g.* trypanosomes) where anatomical data afford no clue for the differentiation of species, the physiological reactions they produce are relied on for specific determination. The variation of the value of characters is a fact that the taxonomist must always bear in mind.

Zoology has from its beginning been an observational science, and even now its purely observational and descriptive aspects have by no means been exhausted. Important conclusions have been derived from observation alone. It is possible to generalise from the observation of a large number of apparent facts, but such generalisations cannot be more than tentative hypotheses, their probable accuracy being proportional to the number of observed facts. It is here that the value of experiment in increasing the proportional accuracy of a hypothesis must be recognised. The observation of an orderly sequence of events in Nature may be considered by some sufficient for a generalisation, but it seems to me that the introduction of a disturbing element in a given series of events must result in giving us a more complete insight into the nature of things. To recognise relationship by the interpretation of structure, physiological reactions and habits of animals, taxonomy would be in a better position if the opinions of the museum zoologist were tested by experiments in development, in breeding, in ecology, and in the habits of the organism. The need for experiment cannot be too strongly emphasised.

Yesterday our astronomy was geocentric; to-day our biology is anthropocentric. Animated Nature has been, and is still, studied and interpreted through human emotions and prejudices, and it is this inability to assume a detached state of mind in studying Nature that is responsible for the lack (as compared with the mathematical sciences) of rigid thinking in biology. It must, however, be admitted that it is easier to maintain an impartial attitude when considering inanimate Nature than is possible in the study of organisms more or less similar to ourselves. We are too apt to regard man as the highest "created" being, superior to all animals, and this view colours most of our observations, especially those of the purely field-naturalist. We have no evidence for supposing that the fair face of Nature exists for the sole pleasure and benefit of man, and until we cultivate the attitude of regarding ourselves as but one kind of organism in the phenomena of life, we cannot hope for careful observations free from personal likes and dislikes. I stress the fallacy of egoism in zoology largely because the systematist has often to depend on the observations of the field-naturalist in his study of the relationships of the animals with which he deals. It is not given to every systematist to be an ecologist or an experimentalist as well, and it is only by the co-operation of untrammelled minds that we can hope for much future progress in biology. S. MAULIK.

Spermatogenesis in Spiders and the Chromosome Hypothesis of Heredity.

REFERRING to several letters which have appeared in NATURE (September 12, October 3, October 17) on the spermatogenesis of spiders, I have now examined the testes of a number of South African spiders, and it is found that the chromatin behaviour and the absolute dimensions of the spermatogonia and spermatocytes may differ extraordinarily in different species, even when these species are not far removed systematically from one another.

In some of the species there is a variable amount of more or less typical spermatogenesis with the formation of spermatocytes by mitosis, but in addition, in all the species investigated by me, there is an extensive production of apparently functional spermatozoa by some form of amitosis, and in certain species typical spermatogenesis appears to be almost entirely absent.

In the case of *Amaurobius sp.*, recently examined by Miss S. D. King, it may very well be that in that species there is a considerable amount of mitosis in the formation of the spermatocytes, but I accept with much less confidence the assumption that the spermatogonia divide only by mitosis. In the thousands of sections of testes which I have examined I have met with very few examples of the karyokinetic division of spermatogonia.

The conclusions which the present observations seem to suggest are:

(1) In spiders it is usual for the spermatogonia to multiply by amitosis.

(2) The spermatocytes arise in a variety of ways, and in certain species the typical mitotic process has been almost entirely superseded by some form of abbreviated or simplified spermatogenesis, and a single spermatogonium may give rise to less than 4 or considerably more than 4 spermatozoa.

In species in which typical sperm-formation is greatly reduced, or practically absent altogether, there may, nevertheless, occur among the spermatocytes a certain amount of incompleted or erratic karyokinesis, but this is sporadic and is not an essential part of the process of sperm-production in those particular spiders. For example, a symmetrical spindle may be formed, but then perhaps no dyaster arises, and afterwards the chromosomes break down and the cell forms spermatozoa in some atypical manner.

(3) In the testes of some species, spermatozoa of two sizes can be distinguished. These may originate in very distinct ways, and the two kinds may be approximately equal in number. There is no evidence that the smaller spermatozoa are degenerate forms. In certain species there seems to be a certain rhythm in the development of the two kinds.

(4) Owing to the fact that in some species the spermatozoa arise almost exclusively by an atypical method, it is not possible to suppose that such spermatozoa are degenerate and incapable of fertilising the ovum.

(5) The spermatozoa may undergo great reduction in size and modification in shape in the epididymis or convoluted tube which connects the testis with the vesicula seminalis. In one species of Attus (?), for example, the spermatozoa in the epididymis become converted into short, stout and perfectly straight rods, and in another species of the same or allied genus they assume a very characteristic and symmetrical fusiform shape. The distinction between large and small kinds of spermatozoa, which may be well-marked in the testis itself, becomes less obvious in the mass of ripe spermatozoa contained in the epididymis and vesicula seminalis.

It is thus clear that there is a remarkable and very interesting diversity in the character of the ripe spermatozoa of spiders.

(6) The multiplication of the spermatogonia by amitosis and the great differences which occur in the behaviour of the chromatin in the origin of the spermatocytes of spiders renders it exceedingly difficult, or impossible, to understand how the complicated factorial architecture, postulated by the chromosome hypothesis of heredity, could be transmitted in any material sense from one generation to another.

In this connexion it may be stated that in a paper about to be published in the *Annals of the Natal Museum*, I am describing the extensive occurrence of amitosis in the early development of the body-tissues and ovary of the embryo of *Palystes natalius*. This amitosis takes place both by binary fission and by fragmentation of the nucleus, and as these cells form a constituent part of actively growing tissues, it is extremely improbable that their offspring should be incapable of dividing by typical karyokinesis.

With such facts as these before us, it is indeed problematical how any definite arrangement of material genes could be maintained in the chromosomes, either in the growth of the tissues or in hereditary transmission.

As a good corrective to the view of the all-sufficiency of chromosomes, and to the tendency to substitute cellular structure in the place of the directive vital activity of the organism, I would recommend a close study of spider spermatogenesis.

ERNEST WARREN.
Natal Museum, Pietermaritzburg,
December 8.

Measurement of Radiation Intensities by Photographic Methods.

THE use of the photographic plate for the comparison of radiation intensities is becoming of greater importance every year. There are two essentially different methods available, and since considerable work is being done in connexion with the method which appears to us least sound, it does not seem out of place to record briefly the general principles involved, with the view of indicating which, in the opinion of the staff of the British Photographic Research Association, is to be preferred.

The first method, and one which has been used very considerably in the past, depends on the characteristics of the particular kind of plate used in making the measurements, that is, it involves the preliminary calibration of the plate. By this is meant a determination of the blackening or photographic density which results from various exposures to known intensities of the same quality of radiation as is to be measured, that is, an accurate "characteristic curve" of the emulsion must be determined. From such a curve the intensity corresponding to any given density is read off. If the actual times of exposure employed when measurements are being made are not the same as those used when the particular kind of plate was calibrated originally, then the problem becomes very complicated owing to the failure of the Bunsen-Roscoe law, which states that a given density is produced by a given value of the product of intensity and time, and is independent of the actual values of each factor. To get over this difficulty the preliminary calibration has also to include a determination of the value of the so-called Schwarzschild's Constant, that is, the value of p in the expression $D = I \cdot t^p$, connecting the density with the intensity and time of exposure. Still further complications arise, since p is not usually a constant, but varies with the intensity. When in addition one realises that these characteristics must be determined for every different wave-length which it is desired to measure, some idea is obtained of the immense amount of preliminary work involved. Further, it is possible for a new batch of plates, presumably of the same kind, to be sufficiently different to upset the results completely.

The main feature of the second method is that the plate is used solely as a detector of equal intensities of the same kind of radiation, that is, the only assumption made is that on adjacent portions of a plate, radiation of the *same* intensity, of the *same* quality, acting for the *same* time, will produce the *same* effect when the plate is developed. To compare the intensities of two beams of the same wave-length by methods based on this principle, the intensity of the stronger beam is cut down until the effect it produces on the plate is the same as that of the weaker for the same time of exposure, etc. For example, if this is achieved when the stronger beam has to be cut down to one-tenth (by a method which does not involve an intermittency effect), then it follows at once that the ratio of the original intensity of the stronger to that of the weaker is 10 : 1. Obviously the great advantage of this method is that it is independent of the kind of plate used, so that all the arduous work of calibration is avoided, and one depends for accuracy, so far as the photographic plate is concerned, only on the constancy of emulsion characteristics over a small portion of any single plate, a fact which must make for considerably greater accuracy. This method, of course, involves the cutting down of the intensity of the stronger beam in a known manner at all wavelengths, preferably by a "neutral" absorbing screen. No difficulty now seems to exist in regard to this, since successful methods have been used by various workers.

As has been stated, this note is prompted by the amount of work which is still being done on the calibration of certain types of commercial plates, presumably with the view of using them for the first method described above. In our opinion the second method is vastly to be preferred.

F. C. TOY.

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Valence Theories and the Magnetic Properties of Complex Salts.

I HAVE followed with considerable interest the discussion which has been recently carried on in NATURE by Messrs. Jackson, Welo and Baudisch on the magnetic properties of the complex compounds of iron and other elements belonging to the first transition group. Two papers on this subject have recently been contributed by me, the first of which was sent in June to the *Philosophical Magazine* and deals with those complex compounds, the magnetic properties of which have been studied by Rosenbohm and Oxley. I have defined with Sidgwick the "effective atomic number Z'" of the co-ordinating atom in any complex compound, as the sum total of all the electrons contained in the former plus the number of electronic orbits which this atom shares with the neighbouring atoms and groups in the co-ordination compound. It can be shown that $Z' = N - E + 2P$, where N = atomic number of the co-ordinating atom, E = its primary valency in the given compound and $P = 4$, 6, etc., according as the complex compound is either fourfold, sixfold, etc.; *e.g.* in the ferrous compound $K_4[Fe(CN)_6] + 3H_2O$, $Z' = 26 - 2 + 2 \times 6 = 36$; while in the case of the fourfold compound of copper $[Cu(NH_3)_4](NO_3)_2$, $Z' = 29 - 2 + 2 \times 4 = 35$. These numbers can be independently calculated by the rule which has been given by Sidgwick.

In the above-mentioned paper I have shown that if Z represents the atomic number of the inert gas which terminates any transition group of elements, *e.g.* in the case of the iron group the inert gas is krypton with $Z = 36$, then all those co-ordination compounds, in which $Z' = Z$, are diamagnetic, while the others are paramagnetic. This result agrees with that given by Messrs. Baudisch and Welo in their letter (NATURE, October 24, p. 606). In a second paper, which was written immediately after the publication of Mr. Welo's letter in NATURE (September 5, p. 359) and has been sent to the *Zeitsch. f. Physik* for publication, I have shown that the number of Bohr's magnetons contained in any co-ordination compound of the first transition group of elements, the magnetic properties of which have so far been studied, is given by $Z - Z'$. The following table shows how the values of the magneton numbers, calculated according to the above rule, agree with the experimentally determined ones:

Compound.	Exp. Magneton No.		Eff. At. No.		
	Weiss's.	Bohr's.	Z'.	Z.	$Z-Z'$.
$[Cr(NH_2)_6]I_3$	19	3 (19·2)	33	36	3
$[Fe(CN)_6]K_4 + 3H_2O$	Dia	Dia	36	36	0
$[Fe(CN)_6]K_3$	10	1 (8·6)	35	36	1
$[Co(NH_2)_6]Cl_3$	Dia	Dia	36	36	0
$[Ni(NH_2)_4]SO_4$	13	2 (14·1)	34	36	2
$[Ni(NH_2)_6]SO_4$	16	2·5 (16·7)	38	36	2
$[Cu(NH_3)_4](NO_3)_2$	9	1 (8·6)	35	36	1

I have placed in brackets next to the Bohr's magneton numbers, the equivalent number of Weiss's magnetons, calculated on the assumption that the co-ordinating atom is in the "S" state. It will be seen that there is good agreement between the calculated and experimentally determined number of Bohr's magnetons contained in this class of co-ordination compounds. It remains to be seen whether further investigations will show that modifications are necessary. Incidentally, the above rule affords further evidence of the reality of Bohr's magnetons.

D. M. BOSE.

University College of Science,
Department of Physics,
92 Upper Circular Road, Calcutta,
November 19.

Mendelian Genes and Rates of Development.

PROF. J. S. HUXLEY and Mr. E. B. FORD have directed attention in NATURE of December 12 to the developmental mechanism connecting the Mendelian gene and the visible character. A field for an attempt to learn something about this mechanism was suggested to me some little time ago by Prof. W. Garstang. Many problems of genetics, he pointed out, are connected with the hair and its colour in mammals, and therefore any process that is concerned in the distribution, development, or succession of hairs should be studied as minutely as possible.

My work has so far been confined to the mouse (*Mus musculus*). A study of the coat was first carried out as a piece of pure morphology in order to provide the necessary basis for the examination of the effects of known genes. A paper on this is shortly to appear. It will be enough to mention the following points. The hairs of the same region of the coat are of several types; the growth of a hair takes place entirely at the basal end, any individual hair taking about four weeks at the most to become fully formed; and, broadly speaking, all the hairs growing at the same time in any small area of the skin pass through much the same stage of development together.

At present I am occupied with the colour pattern of the wild mouse. Agouti, as is well known, is a simple dominant to black. Agouti differs from black in that some hairs have a sub-apical pale band that is in most cases yellow, though some are black throughout. As Prof. Garstang himself anticipated, there has proved to be a simple key to the agouti pattern. On the back of the mouse the presence or absence of the light band can be correlated with hair-type, and in types possessing the band its length and shade can be correlated with the size of the whole hair or of some part of the hair. In every case there is some dark pigment at the apical end, the part of the hair first formed. Within a short distance in yellow-banded hairs the dark pigment gives place partly or completely to yellow, and then proximally black gradually replaces yellow, and no yellow pigment is formed in the rest of the hair. In some cases no yellow pigment can be seen in the light band, but the concentration of the dark pigment is less than in the adjacent regions. In attempting to interpret the facts just outlined, various details of hair development must eventually be taken into consideration. It may be mentioned that in the follicles of two adjacent hairs of the same type, in one the yellow band may be in process of formation after the banded portion of its neighbour has been fully formed and the production of black pigment resumed.

In the light of the discussion of the agouti pattern in rodents by Sewall Wright (*Carnegie Inst., Wash.*, 241, 1916, and *Jour. Heredity*, 8, 1917), and of Onslow's work cited by Huxley and Ford, we may conclude that in the region of the light band the production of black pigment is partly or completely inhibited, while, of course, the colour of any part of a hair depends upon the rate at which different substances are produced.

Some few months ago I was able to discuss this work with Prof. Huxley, who suggested subjecting the animals to different conditions and observing the effect upon the agouti pattern. It also occurs to one that comparative studies should be made on the series of multiple allelomorphs, yellow, white-bellied agouti, agouti, and black. It has not yet been possible to undertake these investigations. They are mentioned as indicating further the possible usefulness of this line of inquiry. F. W. DRY.

The University, Leeds, December 15.

The Leaping Salmon.

THE word salmon, in late Latin *Salmo* (for the fish was unknown to the Greeks), comes from *salio*, to leap; for all salmon run up the streams from the sea in the fall to cast their eggs in clear cold waters, for them to hatch as the waters grow cold. In this regard they are unlike most other fishes (birds and reptiles as well) whose eggs hatch as the weather becomes milder.

When salmon encounter a waterfall, they leap over it if they can. In a broken cascade they may worm their way through and around. This is true in tributaries of the Atlantic and Pacific alike. But while there is but one kind of salmon in the Atlantic, and that one much like a big trout, there are five kinds on our Pacific coast, and those quite different from the Atlantic salmon as well as from one another. These are the king salmon, known also as Chinook or Quinnat; the red salmon of Alaska, known as Blue-back and as Sockeye (*Sukkegh*); the silver salmon or Coho; the calico salmon or Chum; and the hunch-back salmon. All these agree in developing but one set of eggs, dying after once spawning. The noble salmon, king and red, mostly spawn the fourth year; the smaller hunchback the second year, the others at three or four. A few individuals delay the operation, growing to a correspondingly larger size. The red salmon, unlike all others of its kind, enters only streams that have a lake in their course. They spawn in streams at the head of the lake, and in it the young fishes mostly spend their first year. The other species are less particular, but some of them will ascend a stream for fifteen hundred miles (to Lake Laberge in the Yukon country, for example) before the suitable stream is found.

All salmon will leap over a waterfall where it is possible or necessary. I present here the finest picture of a leaping salmon I have ever seen (Fig. 1). An artist has to be keenly on the watch to take a picture like this. It represents a king salmon of about twenty-five pounds springing over the Punch Bowl Falls in the Cascade Range, Oregon, the height being about thirty feet. For this picture I am indebted to a former student, Helen Gibson (now Mrs. Rockhold), resident in Oakland, and for the purpose of placing this charming picture on record, I write this little sketch. DAVID STARR JORDAN.

FIG. 1.—King salmon leaping the Punch Bowl Falls, Cascade Range, Oregon, 30 ft. high.

Detonating Meteors.

THE descriptions of a brilliant meteoric fireball in NATURE of November 28, p. 795, and in two letters dated November 17 and November 28 from Mr. W. F. Denning to the *Times*, give details of the attendant acoustical phenomena which are perhaps worth examination.

It appears that at least 25 miles above Hounslow detonations occurred, and these not only originated sound at that great height, but were also heard loudly at Caterham after passing down through at least 30 miles of the atmosphere.

The loud and thunder-like sounds would appear to be the chief, if not the only, reason for supposing a detonation to take place. Mr. Denning has confirmed in a letter to me that the accepted explanation of the origin of the sound is that there is a detonation resulting from the great heat due to the swift passage of the meteor against the resistance of the air.

The sounds need not necessarily arise from a detonation or explosion, however, for a body moving through the air with a velocity greater than that of sound will on that account give rise to an intense and sudden sound, which in the now familiar case of a high velocity shell or bullet was commonly supposed to originate from the explosion of the propellent charge. The "shell wave" or "onde de choc" to which the loud crack is due is readily understood if Huyghen's principle is applied to this case, supposing the body to be causing disturbances in the air all along its path in the same way as a slowly moving object causes a rushing or tearing sound. Prof. Boys has actually photographed the "onde de choc" of a bullet in flight (reproduced in Barton's "Text-Book on Sound," p. 82), but we have a familiar analogy in two dimensions in the bow wave of a ship.

It is difficult to estimate the speed of sound at a height of 25 miles, but the result of an experiment by S. R. Cook (*Phys. Rev.*, 23, pp. 212-237, September 1906), on the speed of sound in air at liquid air temperatures, might be taken as a limiting case. At 91° A. he found the speed to be 181 metres per second. The speed computed for the fireball of November 15 was about 17 miles per second. At 91° A. this would be about 150 times the speed of sound, and at normal ground temperatures of, say, 283° A. it would be still 80 times the speed of sound. For these high speeds the "onde de choc" would be a conical wave of such a narrow angle that the wave front could be regarded as parallel to the line of flight. This fact might serve to discriminate between sounds due to an explosion at a point in the path of the meteor and that due to its "onde de choc."

In the case of thunder to which the sound of the meteor has been likened, the originating lightning flash is practically instantaneous and usually takes a very irregular path. The sound wave begins with a front shaped like the flash, and this, even more than reflection, probably accounts for the prolonged sound of rising and falling intensity to a distant observer. The flight of a meteor is more regular, and its sound would be expected to be more uniform in intensity than thunder. It may, however, be complicated by the separate "ondes de choc" of fragments thrown off in the course of its flight.

P. ROTHWELL.

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December 18.

Einstein Shift and Doppler Shift.

IN answer to Sir Oliver Lodge's question (NATURE, December 26, p. 938), it depends on our point of view whether the Einstein shift is considered to be imposed on the light at its origin or in course of transit to us. We cannot state the frequency of the ether vibrations without presupposing a system of time-reckoning, and in the non-Euclidean region round the gravitating star the ordinary conventions of time-reckoning have broken down. There is a particular system of time-reckoning (t) commonly used in relativity investigations; but it must be understood that no merit is claimed for this system except that it renders certain calculations easier. In this reckoning the Einstein shift occurs at the origin of the light, and is carried to us by the light without change. But if we pay attention rather to the proper-time (s), which gives us an absolute point of view, atomic vibrations have the same period s wherever they are situated; and the Einstein shift is imprinted on the light as it travels through the non-Euclidean region into the comparatively flat region of space-time where we observe it.

The answer to any problem of observation must, of course, be the same whichever point of view we take. The companion of Sirius will not produce the shift in light reflected by it from another source, because alternatively (1) no change of period t occurs, or (2) the change of period s during the approach is neutralised during the recession. I should add, however, that the so-called reflection of the light of one star by another (often conspicuous in eclipsing variables) is really an absorption followed by re-emission; and this kind of "reflected" light would suffer the Einstein shift.

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Genes and Linkage Groups in Genetics.

IN the flatfishes "mutations" are not uncommon; albinos, piebalds, etc., reversed examples (sinistral individuals of dextral species and dextral individuals of sinistral species), and ambicolorate fish. There are many degrees of ambicoloration, from specimens with a small coloured patch or a few scattered spots on the blind side to others in which the whole blind side is coloured like the eyed side. When ambicoloration is complete, or nearly so, it appears always to be associated with other variations; the migration of the eye is delayed, so that it gets in the way of the dorsal fin as it is growing forward on the head, the scales of the blind side resemble those of the eyed side in structure, the asymmetry of the paired fins is less marked. It is clear that the one thing that holds these variations together is that they are variations towards symmetry, and it is interesting to note that the head, which is the most asymmetrical part of the fish, is the last to be affected; thus it often happens that the whole blind side is coloured except a patch in the orbital region, and that the scales of the blind side are as rough as those of the eyed side except on the head.

The basis of this linkage group—ambicoloration, monomorphic scales, delayed migration of eye—is a tendency towards symmetry. These facts seem to be capable of an interpretation not very different from that given by Prof. MacBride in his letter in NATURE of December 26, p. 938. C. TATE REGAN.

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The Palæolithic Drawing of a Horse from Sherborne, Dorset.

IN the third edition of his "Ancient Hunters," p. 536, Prof. W. J. Sollas states that the drawing of a head of a horse on bone from Sherborne, which I described in 1914 as an example of Palæolithic art, "is a forgery perpetrated by some schoolboys." I read this statement with surprise, because the bone is in a semi-fossilised condition, and I think all who study the specimen will agree that the drawing must have been made when it was fresh. When it was exhibited to the Geological Society, indeed, it was generally accepted as of Palæolithic age. Through the kindness of Mr. Nowell Smith, headmaster, and Mr. R. Elliot Steel, formerly science master of Sherborne School, I have therefore communicated with Mr. Arnaldo Cortesi, the survivor of the two schoolboys who discovered the bone. He writes, "I confirm the genuineness of the find," and remarks that at the age of fifteen years he was too ignorant of the subject to take part in any such "trick" as Prof. Sollas suggests.

I may add that in the autumn of 1923, with the kind permission of Major Wingfield Digby, Mr. Elliot Steel and I examined one of the fissures in the quarry whence the bone is supposed to have been obtained, but we had no success. The teeth of mammoth and rhinoceros from the lower part of the same valley, now in the Sherborne School Museum, are still the only other Pleistocene remains from the neighbourhood. ARTHUR SMITH WOODWARD.

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Aptitude and Achievement.[1]

By Prof. J. McKeen Cattell.

THERE was published in 1890 in *Mind* an article entitled "Mental Tests and Measurements," and in 1896 in the *Psychological Review*, established in the meanwhile in co-operation with Prof. Baldwin, an article entitled "Physical and Mental Measurements of the Students of Columbia University." This was the first series of tests used with a large number of individuals, and it still remains the most extensive undertaking of this character. The students were tested at the beginning of the freshman and the end of the senior year, the women of Barnard College as well as the men of Columbia College.

About an hour was given to the examination of each student, and some thirty measurements were made, ranging from height, weight, and lung capacity, through keenness of sight, discrimination of pitch and reaction time, to memory, imagery, and association. In addition, some forty records and observations were made, ranging from colour of eyes and hair to an estimation of intelligence and straightforwardness. Further, the student at home filled in a blank answering some eighty questions, ranging from the ages and, if deceased, cause of death of his grandparents, to what profession or business he proposed to follow and in what calling he would prefer to succeed if he had his choice. Other information was also available, including class standing in different subjects, success in athletics, and social interests. It is possible to follow the careers of alumni in after life and to measure their children when they in turn come to college at about the same age. In addition to the Columbia students, these tests were made on members of the American Association for the Advancement of Science at three annual meetings, measurements having been obtained of men so distinguished as Simon Newcomb and William James. At the St. Louis Exposition of 1904 a laboratory was set up and tests were made by Prof. Woodworth and Dr. Bruner, both on the visitors and on the racial groups that were represented.

In working over the tests, Dr. Wissler used for the first time in psychology the methods of correlation developed by Francis Galton and Prof. Pearson. The correlations among the grades in different studies were significant and have been the basis of many subsequent studies. The lack of correlations among the measurements was at the time disappointing. It is due in part to the attenuation from measurements that are only accurate when deduced from averages, in part to a real lack of correlation in different traits. For example, a student who is accurate may be as likely to be quick or slow as one who is inaccurate. There is no correlation, but one-fourth of all students will be above the median, one in a hundred in the first tenth, in both accuracy and quickness, and will have a great advantage. The correlations—due to the circumstance that the same abilities and training are involved—discovered among complicated performances, such as class work and intelligence tests, have led to their cultivation and to the neglect of the simpler measurements. The cultivation is desirable, the neglect unfortunate. It is of interest to any one to know where he stands among others in these traits and determinations; some of them, such as colour-blindness or acuity of hearing, which can be measured in a couple of minutes, may be of real use. It is also the scientific method to be followed in analysing the more complicated processes, such as those going under a term so ambiguous as general intelligence.

Estimates of character and of other psychological traits are difficult and untrustworthy. No correlation has been found in the Columbia laboratory between size or shape of head and ability of any sort. There is no known relation between complexion, forehead, nose, chin, or other features and psychological traits. The reading of character by physiognomy or graphology is the occupation of charlatans. It is difficult or impossible to tell even the sex of the individual from the features of the face or from the handwriting. These are, of course, legitimate subjects of study. The full and side face have been photographed through a centimetre netting with a long focus lens, thus obtaining in a moment a large number of determinations, which are on the average as exact as can be got by direct measurement. The method can be used to advantage with children or savages, who do not like to be measured, and it is useful in recording and preserving a large number of determinations, some of which may prove to be of unexpected value. Photographs of the face were cut in parts to determine by what features we recognise the individual, and estimate the age, sex, etc. A study was also made in which individuals were judged first from a photograph, later after a five-minute interview, and then by individuals who knew them well.

It is possible to put judgments of character on a quantitative basis. In the earliest undertaking of this character, five instructors in Columbia University were graded on a percentile scale by twelve fellow-instructors and graduate students. Twenty-four traits or qualities were included, ranging from physical health to efficiency and leadership. There were used the psychological categories of intellect, emotion, and will, together with the quantitative differences to which they have a certain analogy, breadth, intensity and quickness. All these qualities are useful, but it is especially desirable that a scientific man should have broad intellect, an artist intense emotions, a soldier or statesman quick will. We can fancy that these are unit characters which are combined by chance in Mendelian fashion. The probable error in position in a centile order for different traits estimated by twelve observers was only 4 places, ranging from 3 to 5·2, and apart from constant errors there is thus a close agreement. The chances, for example, are even that a man ranked 51 for integrity, with a probable error of 5, is more honest and straightforward than 45 of a hundred of all scientific men and less so than 44. A man ranked 95 for courage with a probable error of 3 is to the best of our knowledge more courageous than 9400 of the 10,000 scientific men of the country, and the chances are even that this position is correct within 300

[1] From the address, entitled "Some Psychological Experiments," of the retiring president of the American Association for the Advancement of Science, delivered at the Kansas City meeting on December 28, 1925.

places. There was greater agreement on mental balance than on physical health; there was least agreement on cheerfulness, most on energy, perseverance, and efficiency.

There is a certain amount of validity in judgments of personal traits, character, and performance, and individual differences in the reliability of the judgments of those taking part in these experiments have been measured, showing a variation in competent observers covering a range of about two to one. It is an accepted truism that success in business and in other directions depends on the wise selection of associates and agents and on the ability to predict how others will act in given circumstances. When we learn to look upon our observations, recollections, beliefs, and judgments objectively, stating in numbers the probability of their correctness, there will be an extraordinary change in our attitude in religion, politics, business, and all the affairs of life.

Before the selection of a thousand students of Columbia University and a thousand American scientific men, a study was made of the thousand most eminent men of history, and this was the basis for the later studies by order of merit. From each of six French, German, English, and American biographical dictionaries or encyclopædias were selected about 2000 of those allowed the longer articles. From the some 6000 individuals so determined were taken those who appeared in at least three dictionaries, and from these were selected those given the greatest average space, the several dictionaries being reduced to a common standard. Thus was obtained not only the thousand men given most attention, but also the order in which they stand. The method further permitted the assignment of a probable error of position, which can be used as a measure of differences in eminence, and, if we assume the distribution of the probability curve, the differences between eminent men and average individuals.

Curves may be drawn showing the historical distribution of eminent men by nationality and by performance. After the Greco-Roman period and the so-called Dark Ages, there is a rise in numbers from the tenth century onwards, but with definite fluctuations in productivity. In the fifteenth century, Italy, England, France, and Germany had nearly the same number of eminent men. Italy was in the lead, but then falls, as does Germany, while England and France rise, their curves crossing through the centuries with nearly an equal number of distinguished men, England surpassing in the number of highest eminence. France reaches its culmination at the end of the eighteenth century. Germany rises rapidly from the second half of the seventeenth century, and the American curve then begins with much promise for the future.

An analysis of the kind of performance shows that France has excelled in war, science, and scholarship, England in politics, poetry, and philosophy, Italy in art. Of the eighteen great musicians, Germany has produced ten, Italy six. Of the fourteen great explorers, England has produced five, Spain four. Though text-books and treatises on history, at least until the most recent period, are mainly concerned with wars and politics, there have been fewer eminent sovereigns, soldiers, and statesmen than scientific men, philosophers, poets, artists, and the like. The rising curves for science, the falling curves for philosophy and the church, are significant. Soldiers have been surpassed in numbers by men of science, and the curves predict a gradual cessation of war and the predominance of science. Similar curves have been made for the percentage of the total population of different countries engaged in war through the centuries, and though the data were inadequate, they also point to the gradual elimination of war. But, of course, the projection of curves is a scientific method that must be used with the utmost caution. By similar methods a list of 1000 American scientific men who died prior to 1900 has been compiled, and the changing interests can be shown by curves. A quantitative study of history is a possibility of the future.

Data have been collected concerning some of the 1000 eminent men of history and a supplementary list of 10,000 has been used, with the view of placing information in regard to them on a statistical and quantitative basis, determining how they differ among themselves and from others, and the conditions favourable to performance. Our present information is from anecdotes and examples from which almost anything can be deduced. We do not even know whether history depends on its great men or whether these are by-products of economic and other forces. We do not know the extent to which their performance depends on heredity and on opportunity.

The distinctions hold not only for men of eminence, but also extend to differences adapting ordinary individuals to the work that they can do best. Thus three types of people, intergrading but often well defined, are those most satisfied and competent when dealing, respectively, with personal and emotional relations, whether the poet or the salesman; with material objects and definite situations, whether the military leader or the mechanic; and with abstractions, whether with the Deity or the atom, or simply with words and figures. In the transportation services, most of the employees have functions separated on the lines of these three types. The clerks, bookkeepers, and stenographers are concerned with words and figures; the conductors and pursers must remember faces, be obliging, ready to answer questions, interested in the affairs of the passengers; these traits are disqualifications for motormen and engineers, who should be concerned about objects and machines. By a rough natural selection those tend to become clerks, conductors, or engineers who are best suited for the work, but probably more than ten per cent. of the employees could be transferred with an average increase of more than ten per cent. in their efficiency; new employees could from the start be assigned to work for which they are best fitted. By the use of the psychological tests that we now have and by research to perfect these tests, the corporations concerned with transportation could effect a direct saving measured by tens of millions of dollars a year, indirectly of a comparable sum through the greater welfare and contentment of their employees.

In addition to the groups already noted, a study has been made of American men of science, selected by the order of merit method. The sciences were divided into twelve groups and the number in each was taken approximately proportional to the total number of scientific workers, ranging from 175 chemists to 20 anthropologists. In each science the men were arranged in the order of the value of their work by ten leaders. The average positions and probable errors were then calculated, giving the order in each science. These were interpolated to give a list of about 2000 names, but in the main only the first thousand have been considered. The list was obtained in 1903 and again in 1910. In 1920 it was compiled for the third time, but by a different method, used partly for its scientific interest, partly in order to avoid too great demands on the time of a few leading scientific men and to prevent any inbreeding from a limited number of judges.

The names and addresses of the scientific men included in each science in the two previous selections were sent to those on the list and they were asked to increase it by about 20 per cent. All those who received more than one vote were then asked to make nominations, and those who received the most votes were added to the list up to a number of names twice as large as was to be selected. The names were then sent in alphabetical order to each of those included, and he was asked to check about half the names to indicate those whose work he regarded as of most merit, with a double check for about one in twenty whose work he considered the most important. Some 2000 scientific men were asked to take part in the selection, and about 1000 complied. The probable error of the position of the individuals was nearly the same as before. The measurement of the validity of a vote has application from the decision of a committee to a national election.

The scientific men are thus arranged in the order of the value of their work with a probable error which shows the correctness of the position assigned to each and also measures the differences between them. It consequently becomes possible to measure the scientific productivity of a region of the country or of an institution and its contemporary strength, with the changes that occur at different periods. The single figure giving the gain or loss in position of a scientific man in the course of ten years condenses a great deal of information and is dramatic in its implications. When we put knowledge concerning men of science on a statistical and quantitative basis, we may hope ultimately to determine the hereditary and environmental conditions favourable to the production and to the productivity of workers in science.

There are large variations in the origin and in the present residence of scientific men throughout the United States. Their birth rate per million of population was 109 in Massachusetts, and decreased from that centre to 47 in New York, 23 in Pennsylvania, 9 in Virginia, less than 2 in the Gulf states. Their present residence tends to correspondence with their place of birth, but some cities and states obtain more scientific men than they produce, and conversely. Scientific activity is moving westward. Of younger men added to the list, the birth rate fell in Massachusetts from 109 to 85, in New York from 47 to 36, whereas it increased in Michigan from 36 to 74, in Minnesota from 23 to 59.

In academic production and possession of scientific men, Harvard leads by a wide margin, though the Johns Hopkins has given nearly twice as many doctorates to those who have attained scientific standing. In 1920 there were at Harvard 73 of our thousand leading scientific men. The numbers in other large institutions were—Columbia, 42; Chicago, 39; Yale, 35; Johns Hopkins, 35; Cornell, 33; California, 31. From 1905 to 1920 the net gain was at Yale, 9; at Harvard, 7; at the Johns Hopkins, 5; at California, 4. Chicago and Cornell were stationary; the net loss at Columbia was 18. The men can be weighted, in which case the relative strength of Harvard becomes greater. The ten strongest departments in each of the twelve sciences have been determined, Harvard among universities standing first in mathematics, physics, chemistry, botany, zoology, pathology, and anthropology; second in geology and physiology. The Johns Hopkins had one of our leading thousand scientific men for 37 students. At Harvard the ratio was 1 : 75, at Yale, 1 : 105; at Columbia, 1 : 202. In the fifteen-year period the Department of Agriculture had a net loss of 9, the Geological Survey of 6, the Smithsonian Institution of 5; the Bureau of Standards a gain, of 11. The Carnegie Institution and the Rockefeller Institute had large gains, as had also the industrial laboratories. The movement of scientific men to the research foundations and laboratories is one of the notable changes of the past twenty-five years.

The list of a thousand scientific men permits not only the measurement of scientific merit and a study of the origin and distribution of scientific workers, but also offers opportunity for obtaining vital and other statistics. Thus, to take an example, the average size of the completed family of the scientific men is 2·2. Voluntary control increased from 48 per cent. of marriages prior to 1880 to 70 per cent. of those contracted in the 'nineties. Childlessness was involuntary in two-thirds of the cases; the standardised two-child family was desired in six cases out of seven. Or again, the brother of a scientific man is two hundred times as likely as another to be himself a scientific man.

We need scientific knowledge concerning scientific men and the conditions favourable to scientific work and to the scientific career. In the course of the week during which these remarks are being written, Secretary Hoover in an address to the Society of Mechanical Engineers has stated that the United States is behind most European nations in scientific research, and President Butler in his annual report has stated that Columbia University cannot replace "older scholars of distinction and large achievements," because "a choice must be made from a larger or smaller group of mediocrities." It may be that we are inferior to other nations and that we now produce fewer scientific men of distinction than formerly, but both statements are open to question. The circumstance that they are made by men of wide information and can be neither proved nor disproved shows the urgent need of correct information.

It is the business of psychology to secure such knowledge, to determine how those fit for scientific research can be selected, what training should be given to them, what positions, opportunities, and rewards are most effective. Scientific men should apply scientific methods to their own work and to securing the widest co-operation. Books and journals, including technical publications for scientific men, others that will interest the "average man" in science and in the wider application of the scientific method, are leading agencies. Science Service, for which the American Association shares the responsibility, should be made a large factor in the dissemination of science. But of all agencies for the promotion and diffusion of science, scientific societies are the most important—the national societies in each science, the state and local academies, most of all the association in which these are united and which at its annual meetings and at all times advances the interests of science and of scientific men and impresses on the widest public the weight and magnitude of modern science.

In spite of the limited value for science of direct introspection, our mental life is part of the real world, and is that part which is of the greatest concern to each of us. It may be, as has been suggested, that psychology lost its soul long ago and is now losing its mind; but it cannot lose consciousness. Our perceptions, thoughts, intentions, and feelings are not only elements in sensori-motor arcs; for us they are also the end to which the whole creation moves. So far as production goes, consciousness may be only a spectator; but it is the ultimate consumer. We shall have in due time a scientific psychology of human welfare, of the things that are beautiful, good, and true. But it will not come until we get these things instead of talking about them; for science has meaning and value only in its usefulness. Psychology may supply economic values equal to those of the physical and biological sciences, human values of even greater significance.

Scientific research and the applications of science in the course of 150 years have increased fourfold the productivity of labour; they have doubled the length of life. Science has made it possible for each to work at routine tasks half as long as formerly and at the same time to consume twice as much wealth as formerly. Fourteen hours of labour, shared by women and children, once provided hovels, lice, and black bread for most people, luxury for a few. Seven hours of labour will now supply comfortable homes, warm clothes, and healthful food for all. If the resources provided by science were properly distributed—as they will be when we have an applied science of psychology—there is now sufficient wealth to enable all to share in the desirable luxuries that science has created, and to enjoy in full measure the most nearly ultimate goods of life—home, friends, things to do, freedom, self-respect.

The better lives secured through the increased wealth provided by science, together with the applications of science to hygiene, medicine, and surgery, have doubled the length of life. In the nations of the west, pestilence and famine have lost most of their terrors; of the three evil fates, only war survives from a pre-scientific and barbarous past. Much is crude and ugly in the modern world; atrophied instincts and aborted impulses must be replaced by the products of a science of psychology before living can become free and fine. But those who call our industrial civilisation materialistic and ignoble have narrow thoughts and scant idealism. They fail to imagine what it means in terms of love and suffering that of ten infants born, formerly only two or three survived childhood, while now eight or nine may live to have children of their own.

The applications of science have abolished slavery and serfdom, the need of child labour, the subjection of woman; they have made possible universal education, democracy, and equality of opportunity, and have given us so much of these as we have. Science has not only created our civilisation; it has given to it the finest art and the truest faith. The advancement of science should be the chief concern of a nation that would conserve and increase the welfare of its people.

The Progress of Directional Wireless Communication.

By Dr. R. L. SMITH-ROSE.

FROM the earliest days of practical wireless communication, it was realised that one of the most important services which this art would render to humanity was its contribution towards the safety of life at sea. The possibility of a ship being able to keep in communication with the remainder of the world during the longest voyages, and, in time of distress, to broadcast an appeal for assistance, has removed much of the terror of shipwreck and fire at sea. A later development, which bids fair to rank second in importance to the above, is the direct application of wireless to aerial and marine navigation. There are, broadly, two methods by which a wireless signal may be used to determine the direction of any given fixed point. In the first, the direction of arrival of the signals from any transmitting station is determined by means of a direction-finder. The second method involves the transmission of a rotating beam of large or small angle and its reception on any suitable receiver.

The wireless direction-finder makes use of the fact that in electromagnetic waves travelling over the earth's surface, the magnetic force of the waves is horizontal and perpendicular to the direction of transmission. If a closed loop or coil of one or more turns with its plane vertical is used to receive such waves, the strength of the signal E.M.F. induced in the loop will be proportional to the cosine of the angle between the plane of the loop and the direction of arrival of the waves. Hence, if the loop is rotated about a vertical axis, the strength of the signals received will pass through successive maximum and zero values at intervals of 90°. A consideration of the case shows that the rate of change of the resulting signal strength is greatest when passing through the zero position, which is therefore the most sensitive condition for the determination of the direction of arrival of the waves. In this zero position the plane of the loop is perpendicular to the direction of the incoming waves and thus of the transmitting station.

There are three practical forms of wireless direction-finder in use to-day operating on this fundamental principle of the simple rotating loop: and it can be shown, both theoretically and experimentally, that the accuracy is of the same order for all the systems, each of which has its own field of application. The limiting accuracy to which the modern direction-finder has been developed is about 1°, which, it may be remarked, is ample for the present-day needs of navigation.

Apart from any defects of instrument design and construction, the direction-finder is subject to errors which are conveniently divided into three classes. In the first class are those due to local conditions surrounding the instrument, such as metal-work, overhead wires, and trees. The currents set up in such objects create a secondary field in the neighbourhood which is superimposed on the primary field of the waves, producing a resultant field the direction of which may deviate seriously from that of the original field. It is usual in selecting a site for a wireless direction-finder on land to attempt to avoid such sources of error, but it is seldom that an ideal site can be found. The small residual errors which are experienced are taken into account by calibrating the station on various fixed transmitting stations. Instances in which an error due to the site of the installation is unavoidable are those of ships and aircraft. In these cases the error in apparent direction varies in an approximately sine-wave form with the direction of the incoming waves relative to the fore-and-aft line of the ship. In such installations, either a correction curve is prepared from observations taken while the ship is swung on a fixed transmitting station, or the error is approximately compensated for by a suitable circuit arrangement.

The second class of error is in the nature of a surface refraction effect and is encountered when the path of the waves lies approximately parallel to the boundary between land and sea. If observations are made on wireless waves crossing a coast-line, the direction-finding instrument indicates that the waves in crossing from sea to land experience a deviation in a direction towards the normal to the coast-line at the point of transit. No satisfactory theoretical explanation of this phenomenon has yet been given, but as the error is frequently of the order of 5°, it is customary to avoid, wherever possible, the taking of bearings on waves travelling in a direction approaching that of a coast-line.

The type of error in the third class presents more difficulty in accurate work, on account of its very erratic and variable behaviour. Fortunately this class of variable error is encountered only when the range of transmission exceeds certain minimum values, beyond which the apparent direction of arrival of the waves is subject to somewhat erratic variations, the frequency and magnitude of which are dependent to a limited extent upon the wave-length employed, the distance of transmission, and also upon the season and time of the day at which the observations are made. During the hours of full sunlight in summer, these variable errors have a maximum value of about 4°. As sunset is approached they increase in frequency and magnitude, and from about one hour before sunset until about one hour after sunrise the apparent direction of arrival of the waves varies rapidly on either side of the true direction over an arc which is often 10° or 20° and may occasionally exceed 90°.

The theory which has been developed to explain these errors rests on the same basis as the theory of the fading of wireless signals and of the mode of propagation of wireless waves around the earth's surface. This theory assumes that the upper ionised regions of the atmosphere are operative in deflecting wireless waves arriving from a transmitting station in such a manner that they are eventually returned to the earth's surface. A direction-finding station will thus receive waves from the transmitter not only horizontally along the earth, but also from a downward direction. If, as is possible from several causes, the plane of polarisation of the downcoming waves differs from that normally encountered in transmission along the earth's surface, the direction of the horizontal component of the resultant magnetic field due to the two arriving waves will in general not be at right angles to the direction of transmission. Thus, although there has been no departure of the line of travel of the waves from the vertical plane connecting transmitter and direction-finder, the latter will indicate an error in the apparent direction of arrival. This theory is being supported by the accumulation of a large and varied amount of experimental evidence, and the investigations concerned provide an excellent means of studying the physics of the upper atmosphere.

DIRECTION-FINDERS IN NAVIGATION.

The discovery of the existence of these errors in the course of the development of direction-finding during the War inspired a lack of confidence in this art among those responsible for marine navigation. Systematic research carried out during the last few years has, however, brought to light a state of affairs which has resulted in the reinstatement of the wireless direction-finder as a direct aid to seamen. While the instrument may be used at ranges of several hundred miles to give a general idea of a ship's position, it is in the making of a landfall after an open-sea voyage, or in the navigation of harbour entrances during bad or foggy weather, that the wireless direction-finder is in demand. The ranges at which it is required to operate with accuracy are seldom greater than 50 miles, and never greater than 100 miles. Now the variable errors described above are only experienced when the range of transmission exceeds 30 miles overland, or 80 to 100 miles oversea. Hence, by a suitable choice of shore transmitting stations, the ship's direction-finder can be used to operate on waves travelling entirely over sea, with the result that, within its required range, about 95 per cent. of the observed bearings fall within a 2° limit of error, which is found to be adequate for most navigational purposes.

During several years' observations, no effect of fog or other surface weather conditions has ever been noticed in wireless direction-finding, which is again fortunate for its use in navigation during times when visual observations are impracticable.

In the application of the direction-finder to aircraft, similar remarks apply as to its accuracy, with one important addition. When the direction-finder is operated on the ground on the transmissions from a machine in the air, the observed bearings are liable to error when the angle of elevation of the machine at the ground station exceeds a small value. This error is caused by the operation of downcoming waves on the direction-finder, but is evidently only appreciable for very short range transmission. The limited amount of experience with direction-finders used in the aircraft itself appears to show that these are destined to be of great service in the future of aerial navigation.

Turning now to other means by which directional wireless may be used in connexion with navigation, we have first the scheme which is practically an inversion of the above systems; that is, a rotating loop or its equivalent is used at the transmitting end and the reception of the signals is carried out on an ordinary aerial. When a closed loop or frame coil with its plane vertical is used for transmission purposes, the variation along the earth's surface is a maximum along a line through the plane of the coil and decreases according to a cosine law to a zero value along the axis of the coil. If, therefore, the coil is rotated about a vertical axis, the strength of signals received at a distance on an ordinary aerial will vary from a maximum when the coil is pointing towards the receiver to a minimum or zero value when it is at right angles thereto. In the practical operation of the device the coil transmitter is rotated at some convenient uniform rate, and arrangements are made for characteristic signals to be transmitted as the coil passes through two positions such as the north-south and east-west lines. By the use of a stop watch at the receiver, the times of rotation of the coil from one of these positions to the minimum signal position can be determined, together with the time of complete rotation. A simple calculation then serves to obtain the direction of the transmitting beacon from the receiver.

The great advantage of this system is that any ship or aircraft which is provided with a wireless receiver can obtain directional observations on these transmitters, and if a suitable distribution of the latter could be arranged, the method would be very useful for navigational purposes. Although it was developed in Germany before the War and an organisation of rotating beacon transmitters was set up, the system has of recent years only been used for experimental purposes, and its commercial application has still to be realised. It may be mentioned here that both this type of directional transmitter and the directional receiver referred to previously can be provided with a simple circuit modification which results in only one signal minimum being produced in a rotation of the coil through 360°. This "sense-finding" attachment results in the removal of the 180° ambiguity which is otherwise inherent in these methods.

The development and use of the above directional systems has been carried out on the wave-lengths chiefly used for communication purposes in aerial and marine wireless, *i.e.* approximately from 300 to 3000 metres. As a result of the development of the thermionic valve to a high degree for both transmission and reception purposes, it has become possible to extend the practice of wireless communication to very much shorter wave-lengths. Among the numerous vistas of development thereby opened up, not the least important is the practicability of resorting to the use of reflectors for concentrating the radiated energy in the required direction of transmission. By the use of suitable reflectors at both the transmitting and receiving end of a point-to-point communication link, the resulting concentration of wireless wave energy can be made equivalent to a magnification of several thousand times as compared with the ordinary transmitter which radiates its energy equally in all directions. This advantage, combined with the inherent properties which waves lying within certain bands of wave-lengths between 15 and 100 metres appear to possess for travelling through the upper atmosphere to great distances with very small attenuation, has already caused a revolution in ideas as to long-distance wireless communication. The resulting opening-up of a large number of fresh communication channels has come as a great boon to wireless engineers struggling with an already congested ether.

THE WIRELESS BEACON.

By the use of waves of length still shorter than those mentioned, it becomes possible to utilise another principle in applying directional wireless to navigation purposes. This consists in combining the aerial system of a wireless transmitter with a suitable reflector so that a fairly concentrated beam of wireless waves is sent out in one direction, which is varied by the regular rotation of the whole arrangement. We have here literally a wireless lighthouse, since it is exactly analogous to the rotating beam of light emitted by certain lighthouses around our coasts. Now it is a well-known optical law that for a reflector to be effective its dimensions must be at least comparable with the wave-length. Hence it is evident that for the rotation of the reflector to be at all practicable, the wave-length employed must be quite small.

In the two revolving beam transmitters which have been set up in the last year or two, the wave-length employed is about 6 metres. In the first station erected at Inchkeith, Firth of Forth, the aerial is a straight vertical wire erected in the focal line of a cylindrical parabolic reflector system of vertical wires. In the more recent station erected at the South Foreland, the aerial system comprises a number of energised aerials arranged in a plane, and in front of a similar parallel system of reflecting wires. The result in each case is the transmission of a beam of limited angle which is rotated uniformly at a rate of about one revolution per minute. Any ship fitted with a suitable receiver for the wave-length employed will then only receive signals as the beam flashes past its aerial. From the code signals heard the direction of the beam at that moment may be read from a simple chart. The range of the station is necessarily somewhat limited, owing to the great absorption of energy of such short waves by the earth. In experiments carried out a short time ago, it was claimed that a maximum range of 100 miles oversea could be obtained.

A great advantage possessed by this system over those previously mentioned is that it should be free from any errors due to its waves being deflected from the upper atmosphere. This fact may prove to be very important in securing a practical working range well in excess of that given by the waves travelling along the earth's surface. An advantage of the use of the short wave-length is the comparative freedom from interference which is experienced at the receiver. On the other hand, the use of such short waves may result in serious errors due to the coastal refraction effect previously mentioned, and to deviation of the waves by such obstacles as cliffs and buildings acting as reflectors.

Helium in Canada.

By Prof. J. C. McLennan, F.R.S., University of Toronto.

IN 1916, at the request of the Admiralty, and in collaboration with my colleagues, Profs. Satterly, Burton, and Dawes, I investigated the natural gases of Canada with the view of ascertaining the amount of their helium content. The gases with the highest helium content were found at that time to be in Ontario and in Alberta. In neither Province was any considerable supply of gas located that contained more than 0·36 per cent. of helium. During the years 1917–1920, with the assistance of Mr. John Patterson, of the Meteorological Office, Toronto, I designed and successfully constructed and operated a semi-commercial plant for extracting helium from natural gas. The gas we worked upon was obtained from an extensive field situated near Calgary, Alberta. During the operation of this plant we extracted in all from 15,000 to 20,000 cubic feet of helium having a purity of 90 per cent. When the Cryogenic Laboratory was instituted in the University of Toronto in 1922, the helium extracted at Calgary became available, and we succeeded in liquefying helium early in January 1923.

Since 1916 many new gas fields have been opened up in Canada, and about two years ago the Dominion Mines Branch decided to make a re-examination of the Canadian natural gases for helium. Mr. R. T. Elworthy was invited to undertake this task, and has carried it through most thoroughly and expeditiously. He found that in Alberta, while some of the natural gases contained less than 0·1 per cent. of helium, a number of them contained so much as 0·25 per cent. In some cases in this Province the helium content ran so high as 0·34 per cent. In New Brunswick none of the natural gases investigated was found to contain more than 0·064 per cent. In Ontario the natural gases varied considerably in their helium content. The gases of Lambton, Kent, and Essex Counties were found to contain not more than 0·15 per cent., while those in the counties of Brant, Haldiman, Lincoln, and Welland were found to have a helium content of from 0·25 per cent. to 0·35 per cent. In the County of Norfolk considerable supplies of gas were produced which ran from 0·4 per cent. to 0·5 per cent. in helium. The gas richest of all in helium was found in Peel County, the content being slightly more than 0·8 per cent. In this field three wells have already been sunk, and the gas is drawn from a horizon approximately 600 feet deep. The wells are consequently shallow, and though the gas supply is only moderate in amount, it has been estimated that the three wells will provide at least 100,000 cubic feet of helium per year.

With the view of rendering the supply of helium permanently available for research work in the University of Toronto, the Hon. the Premier of Ontario recently announced that, under an Order-in-Council, the Government of Ontario had secured, for the Crown, the products of the three wells mentioned, and the natural gas rights as well over a large block of land in the immediate neighbourhood of the wells.

The National Research Council of Canada has endorsed the policy adopted by the Government of Ontario, and is co-operating with the University of Toronto and other organisations in a scheme to establish a helium extraction station in the Peel County gas field, with the object of providing helium for research workers requiring the gas in Canada and probably in other parts of the British Empire as well.

It is fortunate that a supply of helium has been found in such a convenient locality—only some thirty-five miles from Toronto—for although the Government of the United States has extracted enormous amounts of helium from the natural gases of the Western States, its export from the United States is prohibited by law.

If we succeed in making the financial arrangements we have in mind, we hope to be in a position to provide, in the near future, ample supplies of helium for scientific investigations within the Empire.

Obituary.

Prof. J. G. M'Kendrick, F.R.S.

EMERITUS-PROFESSOR JOHN GRAY M'KENDRICK, who died in Glasgow on January 2, was born in Aberdeen in August 1841. By the death of his parents he was at a very early age thrown upon his own resources. When he was but thirteen years of age he was sent to spend a summer with his grandfather at Braco in Perthshire, where, herding sheep daily from 5 A.M. to 8 P.M., he learned to know and love the plants and the animals and Nature in all her moods. Zoology became M'Kendrick's first scientific study; and the youth of seventeen actually demonstrated his little marine aquarium at a conversazione of the British Association which met in Aberdeen in 1859. Here he saw for the first time Faraday, Owen, Murchison and Huxley; science had begun to call him to herself.

Some one suggested that M'Kendrick should qualify for the medical profession, and so, while still apprenticed to a lawyer in Aberdeen, he would rise at five and study until ten, when the duties of the desk claimed him for the day. After passing the "Medical Prelim." at Aberdeen, he went to Edinburgh in 1861 to enter upon the serious study of medicine. Here he heard Goodsir lecture; saw Turner and Joseph Bell ("Sherlock Holmes") demonstrate; listened to Simpson with his European reputation, to Laycock who was a psycho-analyst sixty years ago, and to Christison who was making toxicology a science. M'Kendrick took Goodsir's medal in 1863, and was a prizeman in medicine, obstetrics and surgery. In 1864 he graduated M.D. with distinction at the University of Aberdeen. Years afterwards he summarised his medical course:—"no laboratories, no apparatus, no histology, no bacteriology, and *seven* different theories of inflammation."

After a few months at the Chester General Infirmary, M'Kendrick obtained the position of surgeon to the

Eastern Dispensary in Whitechapel; and as he passed through London to take up his duties he saw the crowd witnessing the execution of Müller for the murder of Mr. Briggs in 1864. For the pain, squalor and vice of Whitechapel, M'Kendrick exchanged the purity and serenity of Glen Nevis, for he became surgeon to the Belford Cottage Hospital at Fort William in 1865. It was in Lochaber that he met Hughes Bennett accidentally, and soon became his assistant. From 1870 until 1873, when Bennett's ill-health compelled him to winter abroad, M'Kendrick had sole charge of the university classes at Edinburgh, which he conducted with marked success. Bennett resigned in 1873, and Rutherford was recalled from King's College, London, to fill the vacant chair, so that M'Kendrick applied for and obtained the lectureship in physiology at Surgeons' Hall, and that at the Dick Veterinary College, Edinburgh. Here it was that he met James Dewar, with whom was begun that joint research which resulted in the discovery of the electric current produced in the retina and optic nerve when a beam of light was allowed to enter the eye.

For the first time in the history of physiology a current of action had been demonstrated in a sensory nerve by the normal stimulation of its end-organ. That Holmgren in Upsala made the same discovery about the same time was, of course, unknown to the Scottish workers. Dewar and M'Kendrick also investigated the physiological action of chinoline and the pyridenes, becoming once more pioneers, this time in researches into the correlation between chemical structure and physiological effect. In 1872 M'Kendrick visited Germany, and met Schultze, Pflüger, Du Bois-Raymond, Ludwig and Helmholtz. His "Life of Helmholtz" is perhaps his best piece of writing; it is an admirable account of a life with little incident in it apart from the scientific discoveries.

In 1876 M'Kendrick was appointed to the chair of the Institutes of Medicine at the University of Glasgow; and here a Department of Physiology was created out of a lecture-room, a sphygmograph, a few microscopes and some diagrams.

M'Kendrick was one of the most agreeable scientific lecturers Scotland has produced: his discourse had all the charm of a tale pleasantly told. In 1871 he had been elected a fellow of the Royal College of Physicians of Edinburgh. In 1881 he was appointed Fullerian professor of physiology at the Royal Institution, in which capacity he delivered many Friday evening discourses, as well as Christmas lectures to the children, and a valuable series on the history of physiology. In 1882 he received the degree of LL.D. from his Alma Mater; and two years later was elected into the Royal Society on the Council of which he afterwards served. He had been president of the Royal Society of Edinburgh, of the Section of Physiology of the British Association, of the Glasgow Philosophical Society; and he acted as examiner in a large number of universities. He delivered two courses of Thomson lectures at the Free Church College at Aberdeen.

M'Kendrick wrote with ease; he was the author of the articles on ear, eye, senses, stereoscope, longevity and nervous system in the "Encyclopædia Britannica," as well as of "The Outlines of Physiology" published in 1878, and ten years later of a "Text-book" in two volumes splendidly illustrated. In conjunction with his assistant, Dr. Snodgrass, he wrote an interesting volume on "The Physiology of the Senses."

From 1892 onwards M'Kendrick, who had always been interested in physiological acoustics, investigated the tracing on the surface of the wax cylinder of the phonograph by a photographic method. Later he devised an apparatus to eliminate the hissing sounds which mar the music reproduced by that instrument. M'Kendrick was very fond of music, of poetry and of animals. He published a volume of devotional verse. His disposition was that of a deeply religious and reverent man who, though enjoying fun, disliked frivolity. His sympathies were wide, his friendships many, his capacity for bringing the best out of every one conspicuous. He urged moderation in the use of strong drink; some of his best addresses are those dealing with this subject.

M'Kendrick married in 1867 a daughter of W. Souttar of Aberdeen, who died in 1898. He is survived by two sons—Dr. J. S. M'Kendrick of Glasgow, and Colonel Anderson M'Kendrick, I.M.S. (retired), director of the Laboratory of the Royal Colleges at Edinburgh—and by one daughter.

D. FRASER HARRIS.

WE regret to announce the following deaths:

Prof. E. G. Browne, Sir Thomas Adams professor of Arabic in the University of Cambridge and fellow and president of Pembroke College, known for his work on Persian literature and on the history and literature of oriental religions, on January 5, aged sixty-three years.

Dr. R. Caton, C.B.E., pro-chancellor and emeritus professor of physiology in the University of Liverpool, and vice-chairman of the Liverpool School of Tropical Medicine, on January 2.

Rev. George Henslow, lately professor of botany to the Royal Horticultural Society, and from 1882 until 1904 president of the Ealing Natural History Society, on December 30, aged ninety years.

Prof. Martin Kirchner, who was prominently associated with the anti-tuberculosis campaign and with the framing of the German laws relating to infectious diseases, on November 11, aged seventy-one years,

Mr. Frank Morey, honorary curator of the Prince Henry of Battenburg Memorial Museum at Carisbrooke Castle, Isle of Wight, and editor and joint author of "The Guide to the Natural History of the Isle of Wight," on December 29, aged sixty-seven years.

Dr. James Murie, formerly assistant-secretary and librarian of the Linnean Society, and naturalist to Consul Petherick's expedition of 1861 to Gondokoro, on December 21, aged ninety-five years.

ERRATUM.—Mr. Edgar R. Waite, the Director of the South Australian Museum, Adelaide, informs us that the details given in the obituary announcement referring to Mr. A. R. McCulloch, which appeared in NATURE of October 24, 1925, p. 620, are incorrect. Mr. McCulloch was zoologist at the Australian Museum, Sydney, where he devoted himself to research on fishes and crustaceans, and his death occurred on August 31, at the age of about thirty-eight years.

News and Views.

PROF. W. GARSTANG, whose address on "Wordsworth's Interpretation of Nature" is published as a Supplement to this week's issue of NATURE, is both a naturalist and a poet, and is therefore appropriately equipped as an exponent of one who made Nature and man his chief poetic theme. Wordsworth felt himself to be a great high priest of Nature, and his spiritual insight was deep and penetrating. In the application of scientific truth to poetic purpose, he was as accurate and trustworthy as Tennyson, but not so rich or minute in his allusions to scientific knowledge. We do not for a moment suggest that the worth of poetry can be measured by the use made of such knowledge, but new natural phenomena and conceptions can extend the range of poetic thought and inspire that emotion which expresses itself in enduring verse. "Poetry," said Wordsworth, "is emotion recollected in tranquility," and it differs from science in being the expression of individual feeling as an end in itself and not as a means of securing general assent to particular conceptions or interpretations of the theme. There is plenty of imagination in science, but it is disciplined and unemotional, and is put to the test of observation with the view of arriving at natural truths, whereas in poetry its object is the communication of pleasure by beautiful phrase or creative fancy. In ornithology there is but one description of the skylark, but in poetry there are scores, and each has a note of its own. That is why we find such poets as Keats, Shelley and Wordsworth interpreting the aspects and operations of Nature in ways that are differently beautiful. Keats by sympathetic human imagery, Shelley by changefulness and its symbolism, and Wordsworth by richness of allusions to everyday aspects of natural objects and events. We are sure that Prof. Garstang's illustrations of Wordsworth's style and genius will be read with pleasure by lovers of literature as well as of science.

THE searchlight of public opinion begins to shine upon the mathematical tripos. A few days ago Prof. G. H. Hardy, in his presidential address to the Mathematical Association, gave it as his considered opinion that the tripos should be abolished. It is not because mathematics are in a better state at Oxford than at Cambridge that he directs his fire against his old university and not his new one, it is because the Cambridge examination is the more important one. Prof. Hardy considers that the nature of the mathematical tripos examination prevents any serious study of mathematics and causes candidates to spend their time learning tripos tricks instead. So bad is the effect of this that among mathematicians of world fame, we produce only about a twentieth of the number that our record in more wholesome times would entitle us to expect. To determine whether a candidate is worthy of a degree, Prof. Hardy would require him to send in a dissertation and judge him upon that. He would in fact adopt the usual continental method. This method of a degree by thesis is also not unknown in Great Britain. Most of our universities allow it as a method for higher degrees. Most of them it is true require the first degree to be by examination, and only in the London B.Sc. do we find an instance of a first degree that can be obtained by thesis.

PROF. HARDY's cure is a more drastic one than that proposed in our leading article of May 10, 1924, p. 665, entitled "Mathematical Physics in University and School." In that article we proposed to broaden the mathematician's studies by including physics, and to make this possible in the three years at the disposal of the student by the severest pruning of both mathematics and physics. Now pruning is always a delicate and difficult operation, and we are inclined to believe that Prof. Hardy's cure is a better one. It has, moreover, the advantage of mending ills that we had not considered. Our complaint was only against the narrowness of the range of the mathematician's studies, his is against the method of treatment of the whole subject. A system in which a candidate, after taking the first part of the mathematical tripos, would be allowed to show up a dissertation instead of taking the second part, is no great departure from the traditions of British universities, since they do already in certain cases allow degrees by thesis. To aim at such a system would seem an appropriate first objective; and when such a system had been adopted and had had some years trial, it would be time enough to consider whether it was right or wise to go further and allow an alternative also to the first part of the examination.

FOR the meeting of the British Association in Oxford, August 4-11, under the presidency of the Prince of Wales, the Council has appointed the following sectional presidents: Section A (Mathematics and Physics), Prof. A. Fowler, professor of astrophysics in the Imperial College of Science and Technology; Section B (Chemistry), Dr. J. F. Thorpe, Yarrow research professor of the Royal Society and professor of organic chemistry in the Imperial College of Science and Technology; Section C (Geology), Dr. S. H. Reynolds, professor of geology in the University of Bristol; Section D (Zoology), Prof. J. Graham Kerr, regius professor of zoology in the University of Glasgow; Section E (Geography), the Hon. W. Ormsby-Gore, M.P., Colonial Office; Section F (Economics), Sir Josiah Stamp; Section H (Anthropology), Dr. J. H. Fleure, professor of geography and anthropology in University College, Aberystwyth; Section I (Physiology), Prof. J. B. Leathes, professor of physiology in the University of Sheffield; Section J (Psychology), Dr. J. Drever, reader in psychology in the University of Edinburgh; Section K (Botany), Dr. W. Bateson, director of the John Innes Horticultural Institution; Section L (Education), Sir Thomas Holland, rector of the Imperial College of Science and Technology; Section M (Agriculture), Sir Daniel Hall, chief scientific adviser to the Ministry of Agriculture. The name of the president of Section G (Engineering) will be announced later.

THE extent to which the technical intelligence service attached to the manufacturing community of Great Britain has been augmented since the War by the new industrial research associations is well illustrated in a paper read before the Institution of the Rubber Industry on December 7 by Dr. S. S. Pickles, the Chairman of the Library Committee of the Research Association of British Rubber and Tyre Manufacturers. The paper dealt with the importance of such a service to the rubber industry, and described some of the work that the Rubber Research Association is doing in this respect. In the short period of its existence the Association has built up a Library which not only possesses a representative reference collection of books, pamphlets, and periodicals (claimed by Dr. Pickles to be without an equal in Great Britain), but also acts as a very complete information bureau on all matters relating to the rubber industry and trade. The Library is provided with a comprehensive classified card index to the contents, which enables it at short notice to supply references to all published information on any branch of the subject, and in addition issues monthly to all its members a *Summary of Current Information* in which are given more or less lengthy abstracts of articles appearing in the scientific and technical press, and of English and foreign patents, notices of new publications and of book reviews, and lists of English patent applications and acceptances. The size of this publication, which will comprise well over 400 pages for the current year, shows how increasingly serious a problem it is for the specialist to keep in touch with what others are doing in the same field, and emphasises once more the vital necessity for the provision of adequate compilations of this nature in all branches of science and technology. Some of the best work in this direction being done at the present time lies to the credit of the research associations, and though the records are not usually available to the general public, their circulation amongst the majority of those intimately connected with the industries concerned cannot but have far-reaching results.

THE use of hydrogen in large-scale chemical manufacture is a comparatively recent development, of which the importance is growing rapidly. Production of synthetic ammonia entails the greatest consumption, but large quantities are also used for hydrogenating liquid oils to convert them into solid, edible fats. The manufacture of hydrogen for the latter purpose was discussed at a meeting of the Chemical Engineering Group of the Society of Chemical Industry on January 8, when Mr. A. E. Knowles read a paper on the electrolytic method of production. The Lane process of making hydrogen, by passing steam over heated iron or a carbonaceous iron-ore and then reducing the iron oxide with water-gas, has fallen out of use for economic reasons, and the Haber-Bosch process of passing water-gas and superheated steam under pressure over a catalyst, though cheaper than any other, is unsuited for producing hydrogen to be used for hydrogenation, because it is always contaminated by much nitrogen. In Mr. Knowles's opinion, the electrolysis of distilled water is alone suitable, and in his paper he described in detail the electrolytic plants in use at Port Bromboro', in Cheshire, and at Bussi, in Italy. The outstanding merits of this process are great purity of the hydrogen, economy in labour and wear and tear of plant, no leakages of electricity or gases, and very cheap production, if cheap electricity is available, and if there is a ready market for the by-product oxygen. Dr. A. C. Thaysen's paper on the production of hydrogen by micro-organisms summarised the history of this method, and gave data concerning the process used in the Royal Naval Cordite Factory at Holton Heath during the War for making acetone by fermenting maize-starch and other amylaceous material. This process yields, in addition to acetone, *n*-butyl alcohol, organic acids, and carbon dioxide, 1·60 per cent. of hydrogen, or 5·5 cubic feet per lb. of grain fermented. A comparatively small plant consuming 20 tons of grain per day produced about 250,000 cub. ft. of this gas at an estimated cost of about 2*s*. per 1000 cub. ft. for collection and purification. Both the electrolytic and the fermentation processes are of especial interest, because they do not involve the use of any fuel.

CAPTAIN P. P. ECKERSLEY, the engineer to the British Broadcasting Company, gave an interesting lecture on January 7 to the Institution of Electrical Engineers on "Past, Present, and Future Development in Wireless Telephony." As a means of communication between individuals, Capt. Eckersley does not anticipate any rapid development in radio telephony, the future of the art will lie mainly in its applications to broadcasting. If in Great Britain at the present time, we connect a microphone with the net-work of wires each of which terminates at a transmitting station, then one voice can be heard simultaneously by ten million people. In Capt. Eckersley's opinion, a final scheme for Great Britain would rely on line relay stations at Glasgow, Leeds, London, and possibly Bristol or Gloucester. The other stations would be connected with these by suitable land wires. The system would be completed by interconnecting Glasgow with Leeds, Leeds with London, and London with Bristol by trunk lines. Future development seems to be leading in the direction of a few stations having large power outputs. Owing to the fact that only about 100 wave-lengths are available for broadcasting, the allocation of them internationally is still a vexed question. He had recently suggested that 82 of them should be allocated to the most important stations, and that sixteen wave-lengths should be reserved for group working. By suitably distributing these sixteen wave-lengths amongst stations of moderate power, there would be little serious interference. If stations could work on exactly the same wave-length, no heterodyne note would be audible. The difficulties in the way are great, but Capt. Eckersley has hopes that they will be overcome. In choosing a site for substations in Great Britain, the criterion must be the crystal set. If the listener can receive broadcasting on a crystal set from a given station, there will be little risk of him suffering appreciably from interference.

THE present exhibit in the house devoted to objects of special interest at the Royal Botanic Gardens, Kew, illustrates living plants of economic value. It includes plants which produce rubber, balata and chicle gum, and a Wardian case packed with young para rubber plants is also exhibited in order to illustrate the manner in which the para rubber and other economic plants have been sent from Kew to all parts of the Empire. Plants of tea, coffee, cacao, and Paraguay tea (the Yerbe de Maté) are examples of the plants yielding beverages. Amongst the fibre-producing plants shown are sisal (Agave), silk grass, China grass or ramie, Manila hemp (*Musa textilis*), Mauritius hemp (Furcræa), and the palm yielding raffia or bass (*Raphia vinifera*). Timbers are represented by young plants of teak, the true mahogany (Swietenia) from Honduras, West African mahogany (Khaya), and West African cedar. Other plants of economic importance exhibited are those yielding cocaine, quinine, ipecacuanha, eucalyptus oil, cloves, cinnamon, camphor, olives and pepper. A plant is also shown of *Taraktogenos Kurzii*, one of the sources of chaulmoogra oil, which is now being used in the treatment of leprosy. The notices with the plants indicate their countries of origin and also the part which has been played by the Royal Botanic Gardens, Kew, in introducing such plants of economic value to the various parts of the British Empire.

ON December 18 Prof. T. H. Havelock read an interesting paper before the North-East Coast Institution of Engineers and Shipbuilders on " Some Aspects of the Theory of Ship Waves and Wave Resistance." The first two sections of the paper must be of great interest to those who, engrossed in the more immediately practical problems that present themselves, have not the opportunity of studying the mathematical theory for themselves or of keeping abreast of its developments. In the first section, it is shown how calculations with travelling pressure disturbances illustrate such problems as the variation of wave resistance with speed, the interference of bow and stern waves and the effect of shallow water. In the second section, the hull of the ship is regarded as equivalent to a certain distribution of sources and sinks in the fluid and this enables such questions as the effect of the form of the water-line section, the length of the parallel middle body, and the effect of variations in draught to be treated. Some notes on the detailed mathematical calculations as they have appeared in Prof. Havelock's published papers is dealt with in an appendix. It is not claimed that the theory has reached a stage at which any new and important practical results can yet be deduced but rather that the general conformity of the conclusions from a pure hydrodynamical theory with known practice is satisfactory from the point of view of future development.

WE regret to learn from the *Chemiker-Zeitung* that a fatal accident has been caused by the unexpected explosion of a mixture of carbon disulphide and liquid air. Organic liquids of many different types, *e.g.* ether, chloroform, ethyl acetate, petroleum, pyridine, etc., have been employed at various times in conjunction with liquid air for the purpose of preparing freezing mixtures, and, so far, explosions have only resulted when carbon disulphide has been used. When this substance is dropped into liquid air there is formed on the surface a crust which may hinder evaporation and thereby cause an explosion unless the crust be pierced as quickly as it is formed. There appears, however, to be some further cause of instability, which has not yet been explained. Prof. W. Biltz, of the Technische Hochschule in Hannover, states that on November 16 a skilled experimenter, Dr. Asbrand, was preparing the mixture in a Dewar flask and had carefully observed all the usual precautions, when the flask suddenly exploded. He was severely hurt, and he succumbed to his injuries on November 28. Dr. Asbrand, who was only twenty-eight years of age, had studied at the University of Göttingen and later at Rostock under Prof. Walden. He had only commenced work at Hannover at the beginning of the present academic year.

MR. DAVID GREENHILL, the Director and General Manager of the Sun Engraving Company, in a lecture before the Royal Society of Arts (published in the Society's journal, December 25), said that colour printing of to-day is done chiefly by lithography, offset, and the three-colour process, the last almost exclusively by letterpress methods, though the photographic principle of the three-colour process is being increasingly used to develop offset work, and also more recently to develop photogravure in colour. The three-colour process is certainly the greatest advance in colour printing of recent years, and with scientific photography and colour selection, skilful fine etching, and very careful machining or printing, it seems to be capable of reproducing almost anything in the way of pictorial representations in colour. The lecturer claimed for British photo-engravers and printers the first place in quality of three-colour process work, though our position is successfully contested in America, Germany, and France, except perhaps in the fine attention to detail and finish. Photogravure, " the most beautiful method of printing yet evolved," has made more rapid strides abroad than Great Britain. It promises to solve the paper difficulty of the letterpress method, which needs a smooth surface, as it readily gives fine results on almost any uncoated paper, and it overcomes various difficulties connected with the inks used in the letterpress method.

IT was suggested in a paragraph in NATURE of January 2, p. 25, that platinised glass might be used instead of neutral tinted glass for solar telescope work. Messrs. Hawksley and Sons, 83 Wigmore Street, Cavendish Square, London, W.1, write to say that they are in a position to supply platinised glass discs of various densities. The Rheinberg methods are employed.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned :—A professor of political science at the London School of

Economics—The Academic Registrar, University of London, South Kensington, S.W.7 (January 22). A medical superintendent in the Infectious Hospitals Service of the Metropolitan Asylums Board—Clerk to the Metropolitan Asylums Board, Victoria Embankment, E.C.4 (January 26). An electrical engineer and electric inspector for the public works department of the Government of Bihar and Orissa—The Secretary to the High Commissioner for India, 42 Grosvenor Gardens, S.W.1 (January 29). An assistant engineer and a junior assistant engineer at the Fuel Research Station, East Greenwich, for research work in connexion with coal purification and internal combustion engines respectively—The Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, Westminster, S.W.1 (January 30). A forestry inspector in the Lands and Agriculture Department of the Irish Free State—The Secretary, Civil Service Commission, 33 St. Stephen's Green, Dublin (January 30). Sir Ernest Cassel readerships in economic geography and in foreign trade at the London School of Economics—The Academic Registrar, University of London, South Kensington, S.W.7 (March 9). A director of research in animal diseases under the Animal Diseases Research Association—The Secretary, 83 Buccleuch Street, Glasgow (March 27). A computer for the Cadastral Framework Party, Gold Coast Survey Department—Crown Agents for the Colonies, 4 Millbank, S.W.1 (quoting M/13965). A chief engineer for the Public Works Department of the Government of Nyasaland—Crown Agents for the Colonies, 4 Millbank, S.W.1 (quoting M/14046).

Our Astronomical Column.

THE TOTAL ECLIPSE OF THE SUN, JANUARY 14.—It is hoped that fine weather has favoured the various expeditions sent to stations on the path of totality passing from East Africa across the Indian Ocean to Sumatra and Borneo. One matter of interest is the shape of the corona, which is known to vary in a cyclical manner with the sunspots, flocculi, and prominences. This eclipse, occurring about midway between sunspot minimum and maximum, may be expected to show a type of corona which is intermediate between the characteristic minimum type, with polar "brushes" and extended equatorial streamers, and that of the maximum type in which the distribution of the corona is more concentric with the sun's disc.

The finer details of the inner corona have sometimes been observed to show local structures which were apparently related either to sunspots, flocculi, or prominences near the limb at the time of eclipse. It may be noted that, on January 14, the region of the sun containing the large sunspots which crossed the central meridian on December 25, was within a short distance of the limb at position angle 106° east of the north point of the disc.

THE JANUARY METEORIC SHOWER.—Mr. W. F. Denning writes: "The weather proved unfavourable for observation on January 3. There were, however, a few brief intervals of clear sky between successive storms at Bristol. About 20 meteors, including 17 Quadrantids, were observed, and they were mostly brilliant objects with long flights and fairly slow motion. The largest meteors were seen at $6^h\ 16^m$, $6^h\ 21^m$ and $6^h\ 50^m$ and at $7^h\ 18^m$ P.M. A fine object with exceedingly slow motion was seen in Gemini and directed from a southern radiant near γ Eridani. Later in the night the sky was more or less clouded, though there were temporary clearances and occasional meteors were observed.

"At $9^h\ 52^m$ P.M. a fireball was viewed from various south-western stations falling in the northern sky. It was directed from a region of the heavens opposite to that in which the radiant of the Quadrantids was situated. Mr. Corder of Bridgwater observed this object and described it as quite equal to Venus; emerald green in colour with a red flash at the end. Several observers saw the meteor from Bristol, and I am collecting details with the view of finding the height, velocity, and radiant point.

"On January 4 unsettled weather continued and the prevalence of clouds frequently interrupted watching. Among the meteors observed were five certain Quadrantids, thus proving the shower's active sustenance. In fact, the evidence obtained this year strongly indicates that this display has lengthened its visible duration in recent times. In 1880, 1886, and some other years, extreme brevity appeared to be a characteristic feature of the shower, though occasional shots were directed from the same radiant on later nights of the month, certainly to January 15."

THE NEW GREENWICH SIDEREAL CLOCK.—The new clock by Short with a free and a slave pendulum, the former in an airtight case, has now been in use for a year, and Mr. W. Bowyer contributed a paper to the Royal Astronomical Society, which was read at the meeting on January 8, in which the performance of the clock is described and analysed.

The rate at the beginning of 1925 was very small, but gradually increased, owing partly to a slight amount of air leakage into the case, which necessitated reduction of the air pressure on one or two occasions.

The clock error could be expressed very exactly by an expression of the form $a+bt+ct^2$. The quantity c remained uniform from January until August, when it underwent a notable reduction, the cause of which is unexplained. It retained the new value until the end of the year.

Dr. Jackson noted that the clock performs so well that it raises the question whether we should not make sidereal time vary uniformly, *i.e.* reckon it from the mean equinox instead of the true, which is affected by nutation. The rate of the former clock was not uniform enough to make the difference an important one.

STAR FISSION AND CEPHEID VARIABILITY.—Dr. Jeans read a paper at the January 8 meeting of the Royal Astronomical Society, in which he elaborated the suggestion made at the previous meeting that Cepheid variables might be stars in which the process of fission was in progress but uncompleted. He gave an estimate of the duration of this stage as compared with the whole life of the star, and concluded that the result accorded with the observed number of Cepheids. He enumerated several points in which the new theory seemed to fit the facts better than the pulsation theory. The latter seemed to require too large a time-lag for the heat produced by compression in the star's interior to reach the surface. Also he found it difficult to picture the whole star pulsating in a single period. He would rather have expected a complex curve like that arising from the striking of several adjacent notes on the piano.

Prof. Eddington continued to defend the pulsation theory, so the matter is one for further discussion and consideration.

Research Items.

THE MAXIMUM POSSIBLE POPULATION OF THE WORLD.—Sir George H. Knibbs concludes in *Scientia* (Nov. 1925) his examination of the world-problems of population, with special reference to the conditions governing the maximum possible population. He gives various estimates (based upon certain considerations) of the possible population ranging from 2942 millions—if the world's existing population increased in ratio of O. R. Baker's estimate of possible increase in the U.S. agricultural area—to 9792 millions —if all existing arable land in the world could support three persons per acre—and a final maximum of 13,440 millions if an average of a person per 2½ acres applied to the whole land surface of the world. But, as he points out, any one estimate is unsatisfactory, because the possible number must depend upon the world's social and economic organisation, upon ethical considerations governing these, and upon the extension of man's knowledge of Nature, and he briefly examines some of the main issues. Assuming that the present standard of living is retained, together with the present national prejudices and egoisms, Sir George considers it doubtful whether the population will ever reach the 5000 million limit. If man better co-ordinates his efforts so as to involve less expense in non-productive effort, then possibly the advance of science may enable the 7000 million limit to be reached. The friendly study of universal economic conditions and of the adjustment of all territorial and economic relations, together with the advances made through systematised knowledge, would perhaps make possible a population of 9000 millions, though this would leave only a small area available to each individual.

JAVANESE ARCHITECTURE.—In December 1924 at a conference of the Java Institute held at Jogjakarta, one of the questions discussed was the value of the ancient Javanese monuments for the present and future Javanese culture. A report of the discussion appears in a translation by Mary A. Rüs in the *Indian Antiquary* for December. Among the speakers, Mr. Maclaine Pont enforced his argument by an analysis of the native and foreign elements in Javanese architecture. The Javanese monuments have many special features which are absent from the Indian buildings, such as the Hala head, the Makara, the spouts. The strong personal element in Indian images gives way in Java to a stereotyped "loveliness." Javanese style is elegant, correct, and accurately balanced, while the Indian is overloaded, overpoweringly vital, more solid, but not pure. The great buildings in Java coincide in date with the struggle for supremacy of the two great dynasties of Palembang and Java, but they represent the spiritual aspirations of a people rather than the feeling of Hindu rulers and upper classes. There must have been an architecture in Java resembling the primitive Jameh style before the Hindu dynasties came. It may be assumed that the Hindu dynasties gained their power in the first instance by missionary propaganda which developed canonical architecture in accordance with Indian proportional outlines. The style of the Javanese school perhaps originated from Central Asia through Indo-China. A close study of the reliefs of the great temple of Borobudur reveals that the sculptors had not the slightest knowledge of Indian structure; that in illustrating Hindu tales, they pictured the persons in complete Javanese surroundings, and this convention was accepted by both priestly and civil builders. The conclusion, therefore, is that influence was brought to bear on Javanese compositions by Hindu rulers and priests who had themselves no technical knowledge.

INDIA AND THE PACIFIC.—In the *Ceylon Journal of Science*, vol. 1, Pt. 2, Capt. A. M. Hocart marshals in some detail the evidence which, in his view, points to an explanation of the similarities of culture in India and in Fiji as due not to a convergence from a distinct origin, but as being essential elements of a resemblance which could only be due to derivation from a common prototype. The points to which he refers are the cross-cousin system with a common *religious* background as shown in certain ritual practices connected with that relationship, a social organisation with a dichotomous system in each case on Capt. Hocart's interpretation, the relation of the elements within the two caste systems, succession and chieftainship and their attendant rituals and the ceremony of fire walking. Certain divergences are to be explained as due to a simplification that has taken place in Fiji. On the whole, Fijian culture is more archaic and is not to be derived from that of the Vedic literature. It is suggested that this pre-Vedic culture may have been carried to the Pacific by a Mongoloid element of North India, which was partly swamped by the aborigines, partly pushed back into the Himalayas and eastward by western invaders. It is at least certain that everything in south Asia is farther east than it was, and the spread of pre-Vedic culture to the Pacific is merely an episode in a great retreat of people along the southern shores of the Asiatic continent and into the islands.

TRIAL AND ERROR IN THE BEHAVIOUR OF CERTAIN ARTHROPODA.—Prof. W. E. Agar gives an account (*Australian Journ. Exp. Biol. and Medical Science*, Vol. 2, Part 3, 1925) of observations on the behaviour of several arthropods, which were placed in conditions unfavourable to their normal activities, from which in each case there were two apparent avenues of escape—one actually leading to freedom, but the other ending in a cul-de-sac and thus failing to afford relief. In the majority of the experiments the animal was placed in the stem of a Y-shaped passage and when it arrived at the bifurcation had to make a choice between the right or left branches. Experiments with Daphnia involving more than 1400 trials failed to reveal any power on the part of the animal to learn by experience, and a similar finding is recorded for water mites. Young crayfish (Parachæraps) gave very different results, soon learning to avoid the wrong passage and to take the right one, *e.g.* in one experiment in which entry into the wrong passage, besides failing to bring freedom, resulted in an electric shock, the animal took the wrong (left) turn at its first trial but then chose the right passage seven consecutive times. The electrodes were then transferred to the right-hand passage and the animal continued to go into this passage for eight more times, receiving a shock each time, but out of the next twenty-one times made the correct choice nineteen times. The difference of intelligence may perhaps be correlated with the modes of life—the crayfish searches out its food by means of its sense organs, while Daphnia has far less initiative, feeding on microscopic organisms collected by a current of water produced by the movement of certain appendages, and shows no evidence of awareness of other animals or bodies.

HERRING INVESTIGATIONS.—The report for 1924–1925 of the Dove Marine Laboratory, Cullercoats, Northumberland, edited by Prof. A. Meek, contains further investigations on herrings from various localities by Mr. B. Storrow, who, in continuing his work of previous years, finds that the fish hatched in 1920 formed the bulk of the catches from the Shetlands, Firth of Forth, and the north of Scotland. Those caught inside the Forth consisted mainly of much younger fish than those caught south of its entrance; a fact regarded as indicative of a southerly migration for spawning. The author believes that there is again evidence pointing to extended migration from the North Sea and the north-west of Ireland to oceanic waters, and there are possibly similar indications from the south-west of England, but the small number of herrings examined from Milford Haven and St. Ives makes this latter statement very uncertain. He sums up with the following words: "Our work points to migrations from seas to or towards the ocean, and return migrations towards or into seas for spawning." Mrs. Cowan adds data dealing with the size of these same samples. In the faunistic notes the spawning of the lug-worm *Arenicola Marina* is described. White patches were seen in the water towards the end of September 1924, in ripple marks on Cullercoats sands, which proved to be masses of sperms, and the worms were found close to the patches. Most of those examined had already spawned, and on the next day all the worms had disappeared. This probably represented the end of the autumn spawning.

SPECTRAL PHOTOMETRY.—The issue of the *Physikalische Zeitschrift* for December 8 contains a report by Dr. H. B. Dorgelo, of the Scientific Laboratory of the Philips Electric Lamp Works, Eindhoven, Holland, on the recent progress in the methods of determining the intensities of spectral lines by photography. He deals first with the expression of the blackening of a photographic plate as a function of the intensity of the light falling on it and the time of exposure. Then follows a section on the comparison of the intensities of the lines of a narrow group in a photograph by means of photometers and the use of semi-transparent wedges of platinum deposited on quartz as absorbers. For lines far apart it is necessary to compare the photograph of each with that produced by a standard source of light for which the relation between energy emitted, wave-length, and blackening produced is known. Several sources, including the tungsten incandescent lamp, are discussed and the various types of spectro-photometers are considered. Some of the most striking results of observations are given, with references to nearly a hundred papers mainly of recent date.

THE VELOCITY OF SECONDARY CATHODE RAYS.—The results of an investigation, in which homogeneous cathode rays are made to fall on a blackened metal surface and the secondary cathode rays are retarded by an opposing electrostatic field, are given in a paper by Dr. A. Becker in the November *Annalen der Physik*. It is shown that the secondary electrons are, in general, considerably more numerous than the primary electrons of similar low velocities reflected or diffused backward, so that it is not difficult to determine the manner of emission of the former. The velocity distribution proves to be identical with that of the δ-radiation. The most probable exit velocity, and therefore the absolute value of all the secondary velocities in the cases investigated, is independent of the velocity of the primary rays; there are signs of a decrease at 24 volts, when the limiting velocity for the excitation of secondary radiation is approached. The most probable velocity of the secondary rays is about 2 volts, which agrees with that found for δ-rays. This velocity depends on the nature of the atom in which the secondary ray originates, and it is on the atom that the amount of energy abstracted from the primary corpuscular ray depends. The results fit in perfectly with the views of Lenard on secondary radiation.

THE PRESERVATION OF FRUIT.—B. T. P. Barker and O. Grove discuss a valuable practical application of sulphur dioxide for the preservation of fruit for subsequent use in jam making or as cooked fruit in the home, in the *Journal of Pomology and Horticultural Science* for December. Starting from the problem as to how to preserve pulped fruit put aside at periods of pressure until its conversion into jam is practically convenient, they have reached the conclusion that a better method of preservation of the fruit is to drop it direct into a 0·08-0·1 per cent. solution of sulphur dioxide in an air-tight container. Red fruits in particular lose their colour, but this is largely though not completely restored on boiling, and the skin of gooseberries and currants is toughened as the result of the treatment, but otherwise fruit so treated seems little if at all inferior to fresh fruit for subsequent cooking purposes, and the sulphur dioxide, being volatile, is driven off on boiling. The method therefore seems likely to supersede pulping for the jam manufacturer, whilst in the home, if used with suitable precautions, it may replace the somewhat more troublesome process of bottling in sterile, air-tight containers.

CHEMISTRY IN THE ARTHAŠĀSTRA.—In two recent issues of the *Chemiker Zeitung* (Nos. 134 and 135, 1925) Prof. E. O. von Lippmann deals with those sections of the Arthaŝāstra which are of scientific interest. The text of the Arthaŝāstra has only comparatively recently come to light; it has been translated into English by Dr. R. Shamasastry, whose edition is that upon which Prof. von Lippmann has worked. The Arthaŝāstra is ascribed to an author of the name Kautilya, who lived in the time of King Chandragupta (321-296 B.C.); it deals with problems and methods of government and administration and is largely compiled from more ancient works of a similar character. The latter fact is of particular importance, since it enables us to get an idea of political and administrative conditions in India in a pre-Buddhist age. In the course of the book many facts of scientific interest are mentioned incidentally; these Prof. von Lippmann has gathered together and enriched with annotations. Among the metals gold takes the first place. It is of two kinds—river (alluvial) gold and rock gold. The pure metal is yellow, brilliant, heavy, and very malleable, and on the touchstone gives a characteristic streak. If impure, gold may be purified by fusing it with an appropriate quantity of lead and afterwards treating it with cow-dung and oil. By melting gold with 1 to 15 parts out of 16 of copper, 16 standard alloys can be obtained; these give streaks which can be compared with those of unknown alloys, and thus the composition of the latter may be ascertained. Pure silver is white, shining, and malleable; if it contains impurities, these may be removed by melting the metal with a quarter of its weight of lead. The most important remaining metals are copper (*tâmra*), lead (*sîsa*), tin (*trapu*), iron (*kâlayâsa*), bronze (*kâmsya*), brass (*ârakûta*), *urtta* or *vritta* (?), and *vaikrntaka*. Other substances described are salt (*kshâra*), alum (*sphatika*), borax, blue vitriol (*tîkshna*), and green vitriol (*kâsîsa*). On heating the latter a poisonous vapour with a strong smell is obtained. A number of plant and animal products are also mentioned, together with several poisons (*yôgapâna*). Although fermented liquors are discussed at some length, there is no indication that alcohol was recognised as a distinct substance.

The Physical and Optical Societies' Exhibition.

THE sixteenth annual Exhibition of Electrical, Optical, and other Physical Apparatus held by the Physical Society of London and the Optical Society on January 5, 6, and 7, was marked by a new departure which added greatly to its interest and popularity. In addition to the trade display of scientific apparatus, a number of demonstrations were provided in illustration of typical results of modern research and new or improved laboratory methods, together with lecture experiments and repetitions of famous historical experiments. After the admission of ticket-holders for the usual two days, the Exhibition was thrown open to the general public for a further day, and the available accommodation at the Imperial College of Science and Technology, South Kensington, was fully occupied throughout. There can be no doubt as to the success of the new section, and it is to be hoped that in future years it may be greatly extended. It makes considerable demands on the time of those who take part in it, as the experiments have to be carefully prepared, but public spirit of this kind has never been lacking amongst physicists. Prof. A. O. Rankine must be congratulated on the feat of organisation which he achieved, and mention must be made of the excellent illustrated catalogue, containing brief descriptions of the more important exhibits, which is now printed in a form suitable for inclusion in the bound volumes of the Proceedings of the two Societies.

In the historical section, pride of place must be given to a repetition of some of Newton's fundamental experiments in optics, prepared by Prof. F. J. Cheshire and Mr. B. K. Johnston. Elaborate care was taken to reproduce the original conditions as closely as possible, and an artificial sun was employed, comprising a source of light to which the required angular diameter was imparted by means of a lens system. Sir William Bragg illustrated Faraday's discovery of electromagnetic induction with apparatus which included the coil actually used by Faraday, and Mr. F. E. Smith showed the British Association rotating coil with which Maxwell measured resistance in primary units.

Amongst the more striking lecture experiments may be mentioned those by Mr. G. L. Addenbrooke on electrostatic attraction and by Dr. L. C. Martin on the polarisation of light. In the former, one sparking-ball of a Wimshurst machine is located over a saucerful of castor oil, a few millimetres above the surface. When the machine is operated, a column of oil rises up and adheres to the ball so long as the latter remains charged. In Dr. Martin's experiment, a beam of plane-polarised light is reflected vertically downwards through a sugar solution clouded by particles in suspension. Since the scattered light is seen with maximum intensity in the plane in which it is polarised, and this plane is rotated by the solution at different rates for different colours, the colour of the beam appears to change along its length. A current weigher designed by Mr. F. E. Smith should be of value in getting students interested in the subject of absolute measurements. It comprises a large fixed vertical coil, and a small central horizontal coil which swings about the horizontal diameter of the former. The current to be measured is passed through the two coils in series and the resulting torque is balanced by weights added to a scale pan, which is attached to the moving coil at a suitable distance from its axis.

The research section comprised exhibits by the more important research departments maintained by the Government and by industrial firms. An interesting item in the Admiralty's contribution was the piezo-electric oscillograph. A quartz strip with metal faces contracts longitudinally when the faces are oppositely charged, and this movement may be applied directly to an optical lever; or two strips of quartz may be cemented together in piezo-electric opposition so as to give a bending movement like that of the bimetallic strips used in thermostats. The National Physical Laboratory's exhibits included a Ewing flowmeter (Dr. E. Griffiths and Mr. J. H. Awbery), in which water flowing upwards in a tube containing a steel ball keeps the ball at a height which depends on the rate of flow. When the tube is vertical the ball may either rotate steadily or oscillate from side to side of the tube: two markedly different calibrations are applicable to these two alternative states. Mr. J. Guild showed a colorimeter which enables any mixed colour to be plotted on the colour triangle by means of purely qualitative measurements. The colour is matched against a mixture of a pure red of known wave-length from a filter with monochromatic light selected from a spectrum, the intensities being varied as required but not measured. A similar observation is made with a blue instead of a red filter, and the two wave-lengths of the colours selected from the spectrum determine the required co-ordinates. A useful laboratory method for splitting mica was shown by Mr. F. Harrison Glew. Two pieces of adhesive tape are attached to the faces of a mica sheet and pulled apart. This operation starts a split which can be extended with a piece of cardboard, and by repeating the process a sufficient number of times, sheets giving interference colours can be obtained without difficulty.

A discourse was delivered each evening during the Exhibition. At the first, on "The Search for Ultra-Microscopic Organisms," by Mr. J. E. Barnard, the attendance was so great that a number of persons were unable to obtain admission, but the speaker's good nature and endurance proved equal to an immediate repetition of the discourse for their benefit. Mr. Barnard explained that the resolution obtainable with a microscope is limited on one hand by the formation of diffraction patterns if the wave-length be too long, and on the other by the opacity of the lens-material if the wave-length be too short. The organisms which are to be photographed have to be grown on a nutritive layer as thin as $0 \cdot 2\mu$, in order to avoid opacity, and the wave-length varies from $220\mu\mu$ upwards, different wave-lengths giving different pictures, owing to differential absorption in the tissues of the object. The microscope combines two lens systems which are appropriate respectively to visible and to ultra-violet radiation, have one quartz lens in common, and are focussed by means of the same mechanism. The latter is calibrated, so that when focussing has been accomplished for visible light of known wave-length, the instrument can at once be set, with the aid of the calibration, for the required ultra-violet illumination. The visible light is used with dark-ground illumination, the ultra-violet with a camera. The organisms of malignant growths are found to be so small that the ratio of their surface tension to their mass is too great to permit of reproduction by central fission, and young individuals make their appearance as a series of thickenings in the cell wall of the parent, which ultimately remain attached thereto only by a spiral filament.

Prof. A. F. C. Pollard's discourse dealt with "The Mechanical Design of Instruments." He claimed that a scientific instrument must be looked upon as a mechanism, for transmitting motion rather than power, and that it must be designed in strict accordance with kinematic principles. The design of a pair or coupling is governed by the principle that a part is fixed in position when its six possible degrees of freedom have all been constrained by the location of six of its points upon six planes. Any further constraint, such as exists in most instruments, is redundant and involves the accurate fitting together of parts, which is far more difficult and costly than the accurate geometrical shaping of parts taken by themselves: the latter process only is required when redundant constraints are avoided, and at the same time the effects of wear due to imperfect fit are eliminated. The principle was illustrated by reference to actual instruments in which such mechanisms as the hole, slot, and plane of Lord Kelvin and the rectangular knife-edge arrangement of Sir Horace Darwin have been employed. As regards the links or rigid parts of an instrument, their design must be governed by a knowledge of what is practicable in a workshop: for example, castings must not have thin parts integral with adjacent thick parts, and holes must not be located so that in drilling them the tool has to work through a face to which it is inclined.

The discourse by Major W. S. Tucker on "Electrical Listening" was illustrated by a number of demonstrations of the properties of microphones, particularly of the tuned microphones associated with his name and used in military sound-ranging. These instruments, in which a very fine hot wire forming one arm of a Wheatstone bridge is arranged as a mesh across the mouth of a Helmholtz resonator, have been given a much enhanced selective sensibility for low frequency disturbances by closely coupling the main resonator with a second resonator of equal pitch. Perhaps the most striking experiment was that in which the speed of a siren was gradually decreased. The resonant microphone in combination with a vibration galvanometer gave a strongly marked indication as each harmonic of the siren passed through the selected pitch. The speaker also showed records of the notes emitted by lightships, taken at a distance of 9 miles, and of thunderclaps, the indicated duration of the latter being much longer than the duration apparent to the ear.

The trade exhibits included a large number of beautiful instruments, many of them new or improved, but space is available for the description of only very few of these. A fuller account has been published in the illustrated catalogue of the Exhibition. The attractive exhibit of Messrs. Adam Hilger, Ltd., included a demonstration with one of their piezo-electric resonators, which are used in standardising wireless wave-lengths. The crystal employed has a mechanical resonance frequency comparable with wireless frequencies, and when it is connected in a suitable circuit, the marked oscillatory piezo-electric E.M.F. which is set up at the fundamental and harmonics of the mechanical resonance enables it to be used for standardising wave-meters, the minimum wave-length being 20 metres. The most interesting feature of the stand occupied by the Cambridge Instrument Co., Ltd., was an improved design of Duddell oscillograph. This instrument is now fully portable, gives direct vision, and three simultaneous records on 50 cm. or shorter strips of ordinary photographic paper, permits of any combination of electromagnetic and electrostatic vibrators, and employs a filament lamp. A novelty in dial recorders is the use of carbon paper by the Foster Instrument Co., the stylus making its impression from behind so as to press the carbon paper upon the semi-transparent record paper against the glass face of the instrument. A new method for preventing the bursting, under excess pressures, of the expanding metal chambers used in barometers and the like is embodied in a thermostat by Negretti and Zambra: in this case the chamber is enclosed in a gas-tight chest and the pressure acts upon it from without. Several ingenious features are also to be found in the Ashdown rotoscope (Elliott Brothers (London), Ltd.) for observing periodic movements such as those of machine parts or even of a flying insect. The stroboscopic shutter is a rotating disc driven by clockwork through a five-speed gear, intermediate speeds being adjusted by means of a governor control. The total range of speeds is from 300 to 20,000 r.p.m. The motor can be started or stopped by turning or holding its shaft with the hand, the difference between static and dynamic friction being utilised to this end in the design; the instrument can be held in one hand when in use.

Much interest was shown in a working example of the Admiralty's apparatus for sounding depths by timing echoes, which is being manufactured by Messrs. Henry Hughes and Son, Ltd. The principle employed is that in which a signal note is emitted at regular intervals and a normally deaf telephone is momentarily rendered sensitive after the lapse of an adjustable interval. The length of this interval when the adjustment is such that the echo can be caught by the telephone measures the depth of the sea. It is believed that the use of a rapidly damped signal note, in combination with other detail improvements, has yielded a fool-proof apparatus. Messrs. C. F. Casella and Co., Ltd., exhibited a surveying instrument designed by Dr. J. S. Owens, for recording the inclination of a bore hole in elevation and azimuth. The instrument contains a complete photographic chronograph, a magnetic compass mounted in gimbals, and a clinometer, and it can be inserted complete into a 2-inch bore hole. It should serve to prevent the distress felt by engineers when a borer, after much apparently successful labour, is found to have behaved like a boomerang. Telephones for the relief of deaf persons have been in use for a long time, but have often proved unsatisfactory owing to the variety in types of deafness. To overcome this difficulty Mr. W. H. Pettifor has designed a test instrument which enables prescriptions to be written for individual patients, analogous to opticians' prescriptions; it is found that each patient requires a combination of microphone and telephone having a particular frequency-characteristic and sensitivity.

In all, some seventy-two firms exhibited. It is, naturally, impossible in the space available in NATURE to describe more than a few of the many important instruments which went to make up this impressive display.

Regional Scientific Work.

THOSE interested in the publications of the local scientific societies in Great Britain will have noticed that after the falling off in the printing of memoirs which occurred during the War, there has been a healthy revival. Notwithstanding the enormous increase in the cost of printing and binding, many of the scientific societies have reached the pre-War standard of their reports, and in some cases have even exceeded that. A perusal of the enormous number of reports and transactions recently issued shows that much more discrimination is now being taken in the publication of papers by the scientific societies. Whether as a result of the Conference of Delegates at the British Association, or the various criticisms and suggestions appearing in Nature and other journals, those responsible for the production of publications of local interest are certainly adding considerably to the value of these transactions by confining the contents as near as possible to the district covered by the societies' activities.

Some societies are sufficiently strong financially, and in scientific workers, to continue printing their publications independently; others, wisely, have amalgamated, and by thorough organisation have produced a joint publication containing the reports of the various committees and sections, which is of permanent value. As an example of the former, we have recently received the *Proceedings and Transactions of the Croydon Natural History and Scientific Society* (Vol. 9, Part 4. Price 5*s*. net). This covers the period February 1923 to January 1925. It includes reprints of the various monthly circulars which the Society has issued containing particulars of the meetings and excursions, with summaries of the work of the sections of archæology, botany, geology, microscopy, physics and chemistry, regional survey, and sociology and psychology. There are the two presidential addresses of Mr. G. M. Davies, one dealing with geology and lines of transport in the Croydon district, and the other with the sea in Surrey, both being of particular value to Croydon naturalists.

An exceedingly valuable part of the publication is that devoted to the meteorological reports for 1923 and 1924, by Mr. F. Campbell Bayard. The cost of compiling and printing these, both from the point of view of time and money, must have been tremendous, and we are not surprised to learn from the Council's report that for both reasons the printing of these reports will not be continued, though full particulars will be sent to the British Rainfall Organisation. Mr. Campbell Bayard is to be congratulated on having accomplished this onerous work for thirty-seven years, and the Society has done well to elect him an honorary member. As a frontispiece to the volume is a really beautiful protrait of the late Mr. William Whitaker, who was one of the most familiar figures at the meetings of many scientific societies, and took a prominent part in Croydon affairs.

The *South-Eastern Naturalist* comes under the second category, and this Society and its organisation is founded upon that of the Yorkshire Naturalists' Union, the pioneer scientific union in the British Islands. The South-Eastern Union's publication, the *South-Eastern Naturalist* for 1925 (lxxxii + 107 pp. Price 5*s*. net), contains a record of the Folkestone congress. As frontispiece is the inevitable "group," which always impresses us as containing portraits of a greater proportion of old people than can be found in any other group of this character! Here the reports and proceedings of the various sections and committees, records of the congress, the obituary notices, etc., are thoroughly well done. The presidential address of Sir John Russell, entitled "The Place of Science in Rural Life," is printed. E. C. Stuart Baker refers to evolution and field naturalists; A. Steven Corbet writes on the marsh-warbler in Britain, with a bibliography; D. Ward Cutler describes life in a garden soil; Prof. A. G. Tansley writes on vegetation of the southern English Chalk; Miss Lillian Lyle on seaweeds of Folkestone—how they grow; A. L. Leach on geological elements in the scenery of south-eastern England (with many interesting illustrations); C. J. Gilbert on the genesis of the Straits of Dover and the creation of Romney Marsh; G. L. Pepler on regional survey as a preliminary to town planning; E. A. Robins and J. H. Pledge on making photographic prints for regional survey; E. A. Martin on problems in anthropology; A. H. Reade on Barfrestone Church; and A. G. Davies on notes on new geological sections in the London district.

In his paper on problems in anthropology, Mr. Martin says: "When we find what looks like an implement and we do not quite know what were its uses, we say it was some kind of scraper. Scrapers were of all ages in human times. Eoliths would make good scrapers. Has any one ever seen a dog or cat take a stone to scrape himself with it? Here again is evidence of the growth of self-consciousness, when man wished to lead a cleanly life. I take it that he did not use his scrapers only for cleaning the skins of animals he had captured and which he wished to utilise as clothing. He would use them to clean himself," and so on.

T. S.

Annual Meeting of the Science Masters' Association.

The twenty-sixth annual meeting of the Science Masters' Association was held on January 5, 6, and 7 at the Household and Social Science Department of King's College for Women, by kind permission of the authorities. There was a large attendance, and the meeting was in every way very successful. After the opening dinner in the refectory of the College, the presidential address was delivered by the Bishop of Birmingham, the Right Rev. Dr. C. W. Barnes.

Dr. Barnes directed attention to the effect of the progress of science upon religious belief, and said that science is now, and must continue to be, an essential element in human culture. It not only gives us a picture of the universe, in which all man's spiritual faculties must find a place, but also helps us the better to understand ourselves and our fellow men. It will, in due course, enable mankind to strengthen its social fabric, to which end it is desirable to check the multiplication of degenerate racial stock. The principles of science and scientific method must be applied universally, even to the phenomena of the religious consciousness. True religion will not suffer if the scientific temper prevails. The absurd contention that if man were a developed ape there could be nothing in him but what the ape possessed is almost forgotten. Using Lloyd Morgan's phrase, Dr. Barnes pointed out that evolution is characterised by the "emergence" of new degrees of reality. Science, he said, can help human progress by destroying false realisations of religious experience and can purify religion by divesting it of accretions which linger from pre-scientific times. It has already banished fear from the minds of educated men by giving them a satisfactory understanding of natural phenomena. It has also banished the gods; the universe is a unity and not subject to the control of super-personalities. Science is built on the postulate of the uniformity of Nature, and its triumphs show that this postulate is sound.

Science has banished the gods: has it banished God? Dr. Barnes is of opinion that, in effect, it has done this if pantheism or naturalism are the interpretation of the universe to which it leads; but no such interpretation is necessary or even probable. That the universe is a self-acting machine is an incredible assumption, and renders the emergence of man's spiritual faculties entirely inexplicable. If, on the other hand, we identify God with the universe, good and evil are alike divine, our moral intuitions are meaningless. Goodness, beauty, and truth must of necessity find a place in our interpretation of the universe, so naturalism and pantheism do not adequately explain the cosmos to which man belongs. Science, then, does not banish God, neither does it banish the conception of the kingdom of God as formulated by the Founder of Christianity. Science, however, can answer none of the ultimate questions. They are not her province. But though her range is limited, within that range she leads us from error to truth, from fantasy to fact. On the truth which science has revealed and is still revealing we have built the new humanism of this age. The religious outlook, in which modern science has been cradled, will not only be able to co-exist with the new humanism, but will derive from it an added power of appeal to the intellect of man.

A vote of thanks to the president was ably moved by a very old and valued friend of the Association, Prof. A. Smithells, and was seconded in a felicitous speech by Prof. Percy Nunn; it was carried with acclamation.

Thursday's programme included a lecture by Prof. Leonard Hill upon "Sunshine, Open Air, and Health," and a discussion upon laboratory assistants, laboratory management, and school exhibitions. On the question of laboratory assistants in schools, a matter which affects most members of the Association very closely, it is felt that some definite scheme for the provision, training, and payment of such men is urgently required, and the committee was requested to make a special inquiry into the subject.

At the business meeting, the momentous decision was taken to institute the formation of local branches. The reasons which led the Association to undertake this step were chiefly two: (*a*) to get into closer contact with local universities, in order to deal more easily with the numerous problems which arise in the teaching of science in schools and in the correlation of school courses with university requirements, etc.; and (*b*) to promote the social side of the Association. Arguments against the formation of branches were put forward, but the weight of the meeting was strongly in favour of the idea. We are pleased to note that, according to the rules drafted for the regulation of branches, non-members who are interested in the objects of the Association may, at the discretion of any branch committee, be invited as guests to meetings of the branch other than a business meeting. This affords opportunity for closer co-operation between the Science Masters' Association and the Association of Women Science Teachers, which, in view of the fact that both associations have the same aims and are faced by the same, or very similar, problems, seems very desirable.

Additional features of the meeting were lectures and demonstrations by Prof. B. J. Collingwood, Dr. C. S. Myers, Rev. F. Aveling, Miss W. Spielman and others, while visits were arranged to the National Physical Laboratory and the General Electric Company's Laboratories. There was also an excellent exhibition of scientific apparatus, and of chemicals, by the leading manufacturing firms, while the publishers' show in the Library was a source of great interest, judging from the crowds of members always present there. The table reserved for books written by members of the Association was striking testimony to the literary activity of science masters, and the members' exhibits of apparatus bore witness to no little ingenuity. It is not too much to say that, of all the numerous associations of teachers in Great Britain, the Science Masters' Association is one of the keenest and most vigorous.

The meeting in January 1927 is to be held at Oxford, an announcement which was received with enthusiasm by the members, who retain a lively recollection of the success of the last meeting there. The new president is Brig.-Gen. Harold Hartley, and the chairman for 1926 Mr. E. J. Holmyard (Clifton College).

University and Educational Intelligence.

PROVISIONAL announcements are now available of a number of free public lectures and short courses by eminent men of science and other scholars, to be given at various colleges of the University of London. Lectures at King's College include three by Prof. A. S. Eddington on the constitution and evolution of the stars, commencing February 22; two by Prof. R. Ruggles Gates on vegetation on the Amazon, commencing February 19; and five by Dr. F. A. P. Aveling on the human will, commencing January 18. At University College, Prof. W. H. Lang is to deliver three lectures on the morphology of the Vascular Cryptogams, commencing March 1, at 5.15 P.M.; Dr. C. M. Ariens Kappers, four on the evolution of the nervous system, commencing March 9; Mr. M. H. Krishna, eight on Indian archæology and anthropology, commencing January 18; Miss M. A. Murray, two on Egyptian architecture and primitive cults in ancient Egypt, commencing January 26; Dr. R. W. Lunt, six on the chemistry of ionisation by collision, commencing February 1; Dr. E. G. Richardson, three on the acoustics of buildings, commencing January 19; and Dr. Geoffrey Martin, one lecture on the theory of fine grinding, on February 12, at 5 P.M. Lectures at the London School of Economics include one by Dr. B. Malinowski on the aims of social anthropology, on February 18, at 5 P.M. Except where otherwise stated, the lectures begin at 5.30 P.M.

ALL universities in Ecuador were closed by a Government decree last August. Commenting on this event, the secretary to the United States Legation, Quito, remarks in an article published in the November issue of *School Life*, that for many years past the degrees of doctor of law and doctor of medicine have been too easy of attainment. To graduate in one of these faculties had come to be looked upon as the best badge of "respectability," and the country is flooded with doctors and lawyers, most of whom are unable to earn a living at their profession, and many of whom are but poorly equipped for it. Similar drastic methods of restricting the recruitment for the legal profession have been adopted in Bolivia, where, however, those who have actually begun their professional courses of study are to be permitted to complete them, after which the law faculties are to be closed down. The editor of *School Life* asks whether it is not time to apply some restriction to the present scale of output of lawyers in the United States, where students of law are more than twice as numerous as students of medicine. Only 46 of the 160 law schools require for the law degree so much as five years of study after the completion of the secondary school course, and only one-fifth of the whole number of law students were in those 46 schools. The other four-fifths were in schools which conferred the degree for four years of study at most. It is suggested that the levelling-up process that has in recent years been applied to medical studies should be now applied to the study of law.

Contemporary Birthdays.

January 15, 1875. Dr. T. G. Longstaff, F.R.G.S.
January 17, 1851. Sir James Cantlie, K.B.E.
January 18, 1868. Sir Leonard Rogers, C.I.E., F.R.S.
January 21, 1855. Sir Henry B. Jackson, G.C.B., F.R.S.

Dr. T. G. Longstaff, traveller in many regions, and Himalayan mountaineer, was educated at Eton and Christ Church, Oxford. His medical training was pursued at St. Thomas's Hospital, London. We quote the following from his paper, "A Mountaineering Expedition to the Himalaya of Garhwal," read before the Royal Geographical Society in January 1908: "I first visited these mountains on my return journey from Tibet in 1905. With my colleagues we hoped to celebrate the jubilee of the Alpine Club by attempting the ascent of Everest, or at least the exploration of its unknown glaciers. We were peremptorily forbidden by the Home Government to enter Tibet."

Sir James Cantlie comes of Banffshire stock. Educated at Milne's Institution, Fochabers, he graduated at the University of Aberdeen, and entering Charing Cross Hospital Medical School in 1871, he afterwards became a lecturer there. Successive students did not fail to carry on the cheery pseudonym of "Jimmy." An ardent traveller, he has been practically all over the world. He visited China in 1887, and was, from 1889 to 1896, Dean of the College of Medicine for Chinese. Sir James is a Knight of Grace of the Order of St. John of Jerusalem. He has written much on surgical science and public health, and is widely known as an exponent of methods of physical training and bodily efficiency.

Sir Leonard Rogers, Lieut.-Col. I.M.S. (retired), was educated at Plymouth College. Entering St. Mary's Hospital Medical School, he became F.R.C.S., 1893, M.D. (Lond.), 1897. Physician and lecturer at the London School of Tropical Medicine, he was, before retirement from the Indian Medical Service, professor of pathology at Calcutta Medical College, and Government Bacteriologist. Sir Leonard is a Fothergillian gold medallist of the Medical Society of London, and has received the Mary Kingsley medal of the African Society for researches in tropical medicine.

Admiral of the Fleet Sir Henry B. Jackson, Grand Officer of the Legion of Honour, was born at Barnsley. Entering the Navy in 1868, he attained his captaincy in 1896, was controller of the Navy, 1905–8, and commanded the Sixth Cruiser Squadron, Mediterranean, 1908–10. Identified with the initial practical use of Hertzian waves for wireless communication between H.M. ships, it may be recalled that on May 15, 1902, Capt. Jackson read a paper before the Royal Society entitled "On some Phenomena affecting the Transmission of Electric Waves over the Surface of the Sea." He stated that in 1895 he began systematic experiments with the view of utilising the effect of Hertzian waves on imperfect electrical contacts for naval signalling purposes. It is interesting to note that on June 12 following, Mr. Marconi also read two papers, one, "Note on a Magnetic Detector of Electric Waves which can be employed as a Receiver for Space Telegraphy"; the other, "On the Effect of Daylight upon the Propagation of Electromagnetic Impulses over Long Distances."

Early Science at Oxford.

January 18, 1683–4. After the reading of ye Minutes, a letter from Mr. Aston to Dr. Plot, was read; which tells us, that some of ye Royall Society are of opinion, that ye Porphyry Pillars, mentioned in an abstract of Mr. John Greaves MS. (lately communicated to us by Dr. Smith, and transmitted to ye Royall Society) were not brought from Mount Sina, as Mr. Greaves supposes, but dug in Ægypt; wherefore it was ordered, that Dr. Huntingdon should be consulted, as to this matter.

A letter from Dr. Hatly of Maidstone concerning some Petrifications found in Kent, was read; He endeavors to prove, that these Petrifications are *Lapides sui generis*, and not made in *animal molds*.

The Ore of ye *Ferrum Noricum* (part of that generous present, with which ye learned Martin Lister Esq has lately oblidged our University) was seen to apply to ye magnet; as also ye common black writeing sand; neither of which can well be supposed to have undergone ye fire. It was then quæried, whether our common ores will not apply, if powdered? Dr. Plot was pleased to take on him ye trouble of trying it.

1686–7. A letter from Mr. Peck of Mayfeild in Sussex, was read. It gave a large account of the man sick of a Feaver mentioned in the Minutes of Dec. the 7th. with some other cases in Physic very remarkable. Mr. President's letter to Mr. Halley concerning the cause of the Trade-winds, was read.

January 19, 1685–6. A letter from Mr. Molyneux, concerning some observations on Mr. Hevelius's *Annus Climactericus* and on his account of ye Lunar Ecclipse on ye 30th of Nov: 1685—A letter from Mr. Brown to Mr. Aston concerning ye Liver as appearing glandulose in a morbid body opened at St. Thomas's Hospitall, London; A letter, subscribed W. Tenon, concerning Dr. Papin's way of raising water, were all communicated and read.

January 20, 1684–5. A foot cubic measure, made by order of ye Society was presented by Mr. Caswell, and Mr. Walker. A catalogue of experiments to be tried with this measure, was drawn up, and put into Mr. Caswel's hands; and a pair of fine scales were proposed to be provided.

A letter from Dr. Middleton, Provost of Kings College, Aberdeen, gives us hopes, of what we have so long, and so earnestly desired, viz a correspondence with Scotland. The Doctor desiring some account of ye manner of our proceedings, ye Secretary is commanded to prepare a transcript of ye Orders, and ye latest Minutes, to be sent him.

A detailed Answer was given to ye 39th Quere of Sir William Petty's Catalogue of Experiments to be tried, (which Q. runs thus, viz: How many shoes of a certain size, a shoemaker can make up in a time given?). It was Affirmed that of ye five first sizes of *children's shoes*, called *Children's pumps*, 12 pair may be made, by a good workman, in one day; that of children's *Eights*, 4 pair are an ordinary days work; and that of Women or Men's *Sixes*, 3 shoes, or 2 pair, are usually a Day's work.

Mr. Musgrave affirmed that 80 lb. of Wedgbury pit coal, kindled at several times, with 4½ lb. of Charcoal, gave a little above ⅝ of a peck of Ashes, which weighed 4¼ lb. avoird:, beside which about a pound of coal was left unburnt in ye grate: so that a pound of this sort of coal, well burnt, does not yeild an ounce of Ashes. A discourse was presented by Mr. Walker, proving from experiment, that ye longer ye wheels of a coach are, (cæteris paribus) ye more easily they may be drawn over a stone, or such like obstacle, that lies in ye way.

Societies and Academies.

LONDON.

Optical Society, December 10.—Col. H. S. L. **Winterbotham**: General principles of photographic surveying. A brief outline is given of the development of photogrammetry from terrestrial and aerial positions, and an indication of some of the points to be considered in the design of instruments required by the photogrammetric surveyor in Britain.—Lieut.-Col. W. N. **MacLeod**: Perspective conditions of photogrammetry. The perspective conditions which must be satisfied in aerial survey work are discussed and the methods of reconstructing these conditions from the photographs obtained are described. Attention is directed to the desirability of designing new apparatus with which to carry out the necessary reconstruction with the requisite accuracy.—Lieut. M. **Hotine**: Some precision problems in air survey. The various factors upon which accuracy in air survey measurements depends are described and suggestions are made as to some of the conditions which should be fulfilled in apparatus employed for such measurements.

The Physical Society, December 11.—E. A. **Owen** and G. D. **Preston**: The effect of rolling on the crystal structure of aluminium. Sheets of aluminium have been examined by the ionisation spectrometer and by photographic methods. When a cast specimen of aluminium containing a number of large crystals oriented at random throughout the body of the material is rolled, the crystals break up into a large number of minute crystals. As the thickness of the material is progressively diminished, the small crystals tend to take up a definite orientation, each crystal having a cube diagonal in the direction of rolling and a (211) plane in the plane of rolling. Two sets of crystals exist in the material after rolling, one set being the optical image of the other in the plane of rolling. The ionisation spectrometer indicates that the type of the space lattice remains unaltered, and that the parameter of the material in the severely worked condition does not differ from that of the annealed material by more than 0·5 per cent.—R. S. **Burdon**: The spreading of one liquid on the surface of another. Purest "conductivity" water in the presence of air spreads very slowly on a clean mercury surface; the spreading is greatly accelerated by traces of acid in solution, and totally inhibited by traces of alkali. All the neutral salts tested, even chlorides of mercury and silver, produce rapid spreading. The concentration of the solution controls the rate of spreading. All acid solutions tested spread rapidly, probably reacting chemically with the mercury. One part of hydrochloric acid in ten million of water definitely accelerates spreading. A drop of very dilute acid spreads rapidly to cover a definite area and stops, any further spreading being as slow as that of water. The area covered during the rapid stage is proportional to the number of acid molecules present, and is larger than would be expected if a monomolecular layer of the appropriate salt were formed on the mercury surface. Electrostatic fields up to 4,000 volts/cm. applied perpendicular to the surface produce no visible results. Placing a platinum wire from one terminal of a battery in the mercury and from the other terminal in the drop, and applying small voltages, causes spreading even in alkalis if the mercury be positive, and prevents spreading even in dilute acids if the mercury be negative. Photographs show that the spreading drop is preceded by a well-defined ridge.—J. T. **Combridge**: On the advance of the perihelion of mercury. Attention is directed to the infinite possibilities of obtaining the Einstein equation for the orbit of a planet by using Newtonian mechanics with an extended potential function. Observational tests being equally satisfied, Einstein's theory is to be preferred on account of its extensive unity and the spontaneity of its results.

Linnean Society, January 7.—Eric Marsden **Jones**: On the fertilisation of *Primula vulgaris* Huds. Observations were made by day and night in a wood at Potterne in Wiltshire in order to ascertain with the greatest degree of accuracy the part that day- and night-flying insects might play in the pollination of this plant. During day observations, five important species of insects were seen pollinating frequently. During night observations the only visitors seen were *Meligethes erythropus*, *Tachyporus salutus*, and *Forficula auricularia*, which are of no value from a pollinating point of view. Two blocks of 50 plants each were covered alternately day and night as a control. The patch from which insects were excluded at night produced 343 capsules, while the one exposed by night, and from which day-flying insects were excluded, produced only 5, for which there is an explanation. Six plants covered entirely day and night were absolutely sterile. It seems, therefore, that diurnal insects pollinate efficiently, and that nocturnal Lepidoptera play no part whatever in the pollination of *Primula vulgaris*.—M. A. C. **Hinton**: Persistent growth in the water vole and old age in the wart hog. A contribution to the growth and death discussion. The ancestors of the voles possessed tuberculate teeth of limited growth adapted for bruising and crushing the relatively soft and succulent substances composing a mixed diet. The voles have acquired the power of subsisting upon coarse, tough, vegetable substances, and this has led to modifications, particularly in the molar teeth. These have become tall-crowned, prismatic structures adapted for slicing and shearing the food; and the dentinal pulps and enamel organs of the teeth appear to remain active throughout life. The water vole (*Arvicola amphibius*) is remarkable in another way. In the oldest individual known, not only were the molar teeth actively growing at the moment of death but the skeletal development was still incomplete. It would seem that the water vole and some of its relations never stop growing. The last molar and the enormous canines of the wart hog have been described as being persistently growing teeth. Recently acquired material shows that, if the wart hog lives long enough, these teeth finish growing, develop roots, and wear out, so that in due course the animal becomes senile and dies. Probably if we could secretly defend a water vole from accident indefinitely while exposing it to normal Microtine existence, its growth would cease, and it would proceed to old age and death like a normal mammal.

SYDNEY.

Linnean Society of New South Wales, November 25.—A. **Philpott**: The labial palpi of *Trichophysetis cretacea* and *Argyria amœnalis*. Modifications of the palpi occur in males although the females are quite normal.—John **Mitchell**: Descriptions of new species of Leaia. The genus is confined to rocks of Carboniferous and Permian ages; and consequently its occurrence, in great variety, in the Newcastle Coal Measures forms one of the most convincing proofs of the Permian age of these measures. Thirteen species are described as new.—H. M. **Hale**: The development of two Australian sponge-crabs. Two marine crabs, an oxyrhynch (*Paranaxia serpulifer*) and a dromiid (*Petalomera lateralis*), do not pass through the usual free-swimming larval stages, the young leaving the female in the adult form. In the latter, at least two advanced juvenile stages are spent in the brood-pouch of the female. The metamorphosis is almost completely suppressed in another sponge-crab (*Cryptodromia octodentata*) and a third (*Platydromia thomsoni*) probably has a "direct" development.—Ida A. **Brown**: Geology of the Milton District. Within a radius of ten miles of Milton there are a number of outcrops of igneous rocks. An account is given of the albitisation and of the history of the intrusions.—I. M. **Mackerras**: The Nemestrinidæ (Diptera) of the Australasian region. Of the 40 specific names hitherto proposed, 22 are considered as valid and 2 cannot be placed; 1 genus, 16 species, 3 subspecies and 1 variety are described as new.—E. W. **Ferguson**: Description of a new species of Mycetophilidæ (Diptera) with luminous larvæ. A new species of Arachnocampa is described from Ida Bay Caves, Tasmania.—L. **Harrison** and Hazel C. **Weekes**: On the occurrence of placentation in the scincid lizard, *Lygosoma entrecasteauxi*. The occurrence of true placentation in two not very closely related scincid lizards, Lygosoma and Chalcides, in Australia and Europe respectively, indicates that the allantoplacenta is a functional adaptation which may have arisen independently many times in evolution, and upon the mere occurrence of which phylogenetic statements cannot justifiably be based. A consideration of reptilian placentation suggests three stages, chorioplacenta, omphaloplacenta and allantoplacenta arising in that serial order, both in ontogeny and phylogeny.—W. J. **Phillipps** and F. J. T. **Grigg**: The salinity of inshore oceanic waters of Australasia in relation to fishes.

Official Publications Received.

The Indian Forest Records, Vol. 11, Part 10 (Economy Series): Notes on the Antiseptic Treatment of Assam Timbers for Railway Sleepers. By J. H. Warr; assisted by S. Kamesam. Pp. iv+106. (Calcutta: Government of India Central Publication Branch.) 1.14 rupees; 3*s*. 3*d*.

Meteorological Office: Air Ministry. Advisory Committee on Atmospheric Pollution: Report on Observations in the Year ending March 31st, 1925. Forming the Eleventh Report of the Committee for the Investigation of Atmospheric Pollution. (M.O. 280.) Pp. 46. (London: H.M. Stationery Office.) 5*s*. 6*d*. net.

Madras Fisheries Department. The Fishing Methods of the Madras Presidency. By James Hornell. Part 1: The Coromandel Coast. (Report No. 2 of 1924, Madras Fisheries Bulletin, Vol. 18.) Pp. 59-110. (Madras: Government Press.) 12 annas.

Society for the Provision of Birth Control Clinics. Annual Report 1924–1925. Pp. 14. (London: 153a East Street, S.E.17.)

Dove Marine Laboratory, Cullercoats, Northumberland. Report for the Year ending June 30th, 1925. (New Series 14.) Edited by Prof. Alexander Meek. Pp. 58. (Cullercoats.)

Leeds University. Report to the Worshipful Company of Clothworkers of the City of London of the Advisory Committee on the Departments of Textile Industries and Colour Chemistry and Dyeing, during the Session 1924–25. Pp. 16. (Leeds.)

University of California Publications in American Archaeology and Ethnology. Vol. 17, No. 7: Archaic Culture Horizons in the Valley of Mexico. By A. L. Kroeber. Pp. 373-408+1 plate. (Berkeley, Calif.: University of California Press.) 45 cents.

Smithsonian Institution: United States National Museum. Contributions from the United States National Herbarium. Vol. 24, Part 7: The North American Species of Stipa; Synopsis of the South American Species of Stipa. By A. S. Hitchcock. Pp. xi+215-289. (Washington: Government Printing Office.) 15 cents.

Department of the Interior: Bureau of Education. Bulletin, 1925, No. 17: Professional Staff of State Departments of Education. By Arthur Wesley Ferguson. Pp. iv+64. (Washington: Government Printing Office.) 10 cents.

The Physical Society of London. Proceedings, Vol. 38, Part 1, December 15. Pp. 92. (London: Fleetway Press, Ltd.) 6*s*. net.

Transactions of the Royal Scottish Arboricultural Society. Vol. 39, Part 2, October. Pp. 89-218+31-39. (Edinburgh.) 3*s*.

Bernice P. Bishop Museum. Bulletin 15: Samoan House Building, Cooking and Tattooing. By E. S. Craighill Handy and Willowdean Chatterson Handy. Pp. 26+7 plates. Bulletin 16: Juan Fernandez and Hawaii, a Phytogeographical Discussion. By C. Skottsberg. Pp. 47. Bulletin 17: Music in the Marquesas Islands. By E. S. Craighill Handy and Jane Lathrop Winne. Pp. 51. Bulletin 18: String Figures from the Marquesas and Society Islands. By Willowdean Chatterson Handy. Pp. 92+4 plates. Bulletin 19: Hawaiian Fungi. By Frank Lincoln Stevens. Pp. 189+10 plates. Bulletin 20: Tropical Cyclones of the Pacific. By Stephen Sargent Visher. Pp. 163. Bulletin 21: Report of the Director for 1924. By Herbert E. Gregory. Pp. 55. Bulletin 22: Fishes of Guam, Hawaii, Samoa and Tahiti. By Henry W. Fowler. Pp. 38. Bulletin 23: Archaeology of the Marquesas Islands. By Ralph Linton. (Bayard Dominick Expedition, Publication No. 10.) Pp. 187+15 plates. (Honolulu, Hawaii.)

Imperial Department of Agriculture for the West Indies. Report on the Agricultural Department, St. Vincent, for the Year 1924. Pp. iv+46. (Trinidad.) 6*d*.

National Museum of Wales. Eighteenth Annual Report, 1924-25, presented by the Council to the Court of Governors on the 23rd October 1925. Pp. 42+7 plates. (Cardiff.)

Diary of Societies and Public Lectures.

SATURDAY, JANUARY 16.

SCOTTISH JUNIOR GAS ASSOCIATION (at Royal Technical College, Glasgow), at 7.—D. Garrie: Paper.

MONDAY, JANUARY 18.

ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge), at 5.—The New Photo-Theodolite of Mr. A. Wild (Report and Discussion).

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith; Fossil Remains of Ape and Man: (1) The Anatomical Characters of the Galilee Skull.

FARADAY SOCIETY (at Chemical Society), at 5.30.—B. B. Banerji: The Electrode Capacity and Resistance of Electrolytes for a Wide Range of Frequencies.—J. A. V. Butler, W. E. Hugh, and D. H. Hey: The Effect of the Electrode Material on Oxidation Potentials.—R. E. W. Maddison: The Electromotive Behaviour of Cupric Oxide.—A. Highfield: The Colloidal Properties of Nitrocellulose Sols in Mixed Solvents.—E. P. Perman and T. Lovett: Vapour Pressure and Heat of Dilution of Aqueous Solutions. Part I. (*a*) Vapour Pressure of Aqueous Solutions of Urea; (*b*) Heat of Dilution of Aqueous Solutions of Urea.—W. Taylor: A Note on Kinetic Activation as a Factor in Gas Reactions.

INSTITUTION OF AUTOMOBILE ENGINEERS (Loughborough Graduates' Meeting) (at the College, Loughborough), at 7.—C. Legge: Sparking Plugs.

INSTITUTION OF ELECTRICAL ENGINEERS (Teeside Sub-Centre) (at Cleveland Technical Institute, Middlesbrough), at 7.15.—E. E. Dunn, W. S. Ramsdale, and others: Informal Discussion on The Isolation, Location, and Repairs of Faults.

JUNIOR INSTITUTION OF ENGINEERS (North-Western Section) (at 16 St. Mary's Parsonage, Manchester), at 7.15.—W. D. Adamson: The Importance of the Selling Aspect of Production Planning.

INSTITUTION OF AUTOMOBILE ENGINEERS (Scottish Centre) (at Roya Technical College, Glasgow), at 7.30.—J. D. Parkes: Logic applied to Failures.

INSTITUTION OF ELECTRICAL ENGINEERS (Mersey and North Wales (Liverpool) Centre) (at Liverpool University), at 7.30.—A. P. Trotter: Illumination and Light (Faraday Lecture).

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—Award of Prizes and Studentships.

ROYAL SOCIETY OF ARTS, at 8.—H. P. Shapland: The Decoration of Furniture (Cantor Lectures) (1).

ARISTOTELIAN SOCIETY (at University of London Club), at 8.—Dr. F. W. Thomas: Conventional Existence.

CHEMICAL INDUSTRY CLUB.

INSTITUTE OF CHEMISTRY (Manchester and District Section) (at Manchester).—C. Hollins and others: Discussion: Chemical Nomenclature.

TUESDAY, JANUARY 19.

ROYAL ANTHROPOLOGICAL INSTITUTE (Edinburgh and the Lothians Branch) (at Synod Hall, Edinburgh), at 5.—Dr. J. Ritchie: The Arrival of Man in Scotland.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. J. A. Crowther: X-rays and Living Matter (1).

ROYAL STATISTICAL SOCIETY (at Royal Society of Arts), at 5.15.—R. J. Thompson: The Productivity of British and Danish Farming.

ROYAL SOCIETY OF MEDICINE, at 5.30.—General Meeting.

MINERALOGICAL SOCIETY (at Geological Society), at 5.30.—Dr. C. E. Tilley: Some Mineralogical Transformations in Crystalline Schists.—Dr. A. Brammall: Gold and Silver in the Dartmoor Granite.—A. H. Hallimond: On the Chemical Classification of the Mica Group. II. The Basic Micas.—G. Greenwood: The Construction and Use of an X-ray Goniometer.

INSTITUTE OF MARINE ENGINEERS, at 6.30.—W. Blane: Poetry and the Engineer.

INSTITUTION OF ELECTRICAL ENGINEERS (East Midland Sub-Centre) (at Loughborough College), at 6.45.—A. B. Mallison: Justifiable Small Power Plants.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Scientific and Technical Group), at 7.—W. D. Baldsiefen, F. F. Renwick, and Dr. V. B. Sease: Silver Iodide in Photographic Emulsions.

INSTITUTION OF AUTOMOBILE ENGINEERS (Coventry Graduates' Meeting) (at Coventry), at 7.15.—E. W. Sisman: The Straight Eight Engine.

SOCIETY OF CHEMICAL INDUSTRY (Birmingham and Midland Section) (at Birmingham University), at 7.15.—B. D. Porritt: Early Days of the Rubber Industry.

INSTITUTION OF AUTOMOBILE ENGINEERS (Wolverhampton Centre) (at Wolverhampton), at 7.30.—H. Briggs: The Elimination of Noise in the Motor Cycle.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Western Centre) (at College of Technology, Manchester), at 7.30.—A. P. Trotter: Illumination and Light (Faraday Lecture).

INSTITUTE OF METALS (North-East Coast Local Section) (at Armstrong College, Newcastle-on-Tyne), at 7.30.—Prof. F. C. Thompson: The Principles which Govern the Heat Treatment of Non-Ferrous Alloys.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Middlesbrough Branch) (at Cleveland Scientific and Technical Institute, Middlesbrough), at 7.30.—S. E. Burgess: Public Works and Housing at Middlesbrough.

ROYAL ANTHROPOLOGICAL INSTITUTE (Indian Section), at 8.15.—Discussion on Periods in Indian History.

British Institute of Philosophical Studies (at Royal Society of Arts), at 8.15.—A. D. Lindsay: The Theory of Sovereignty and the League of Nations.

WEDNESDAY, January 20.

Royal College of Surgeons of England, at 5.—Sir Arthur Keith: Fossil Remains of Ape and Man (2): The Interpretation of Endocranial Casts taken from Skulls—Ancient and Modern.
Geological Society of London, at 5.30.—T. O. Morris and Prof. W. G. Fearnsides: The Stratigraphy and Structure of the Cambrian Slate Belt of Nantlle (Carnarvonshire).
North-East Coast Institution of Engineers and Shipbuilders (Graduate Section) (at Bolbec Hall, Newcastle-upon-Tyne), at 7.—F. Hamilton: Locomotive Valve Gears.
Institution of Automobile Engineers (Birmingham Graduates' Meeting) (at Birmingham), at 7.30.—E. W. Sisman: The Straight Eight Engine.
Institution of Electrical Engineers (Sheffield Sub-Centre) (at Royal Victoria Hotel, Sheffield), at 7.30.—G. H. Nelson, H. W. Walker, D. M. Rait, and D. H. Davies: Regulations (Short Addresses).
Royal Microscopical Society (Annual Meeting), at 7.45.—A. Chaston Chapman: The Fungi Imperfecti, and a Further Plea for an Institute of Industrial Micro-Biology (Presidential Address).
Royal Meteorological Society (Annual General Meeting), at 7.40.—Presentation of the Symons Medal to Lieut.-Col. E. Gold.—C. J. P. Cave: Address on the Work of the Society during the Past Year, followed by an Exhibition of Lantern Slides of Clouds.
Royal Society of Arts, at 8.—Dr. H. H. Morgan: Problems in Paint and Varnish Technology.
C.B.C. Society for Constructive Birth Control and Racial Progress (at Essex Hall, Essex Street), at 8.—L. Jefferson: Religion and Birth Control (to be followed by a discussion).
Entomological Society of London, at 8.—Annual Meeting.
Institution of Structural Engineers, at 8.—Major R. A. B. Smith: Concrete Roads in America, and the Application of their Principles of Design and Construction to Great Britain.
Society of Chemical Industry (Nottingham Section) (at Nottingham).—Dr. Clibbens: Dyeing and Bleaching of Cotton.
Society of Glass Technology (at Manchester).

THURSDAY, January 21.

Royal Society, at 4.30.—W. Barlow: The Configuration of the Carbon Atom and the Geometrical Relations of this Configuration to those of other Atoms as evidenced in the Chemical and Crystallographic Structures of Organic Chemistry. Part I.—R. E. Gibbs: Structure of a Quartz.—H. J. Gough, D. Hanson, and S. J. Wright: The Behaviour of Single Crystals of Aluminium under Static and Repeated Stresses.—C. H. M. Jenkins: The Determination of the Vapour Tensions of Mercury, Cadmium, and Zinc by a Modified Manometric Method.—*To be read in title only*:—Ursula Andrewes, Dr. Ann C. Davies, and Prof. F. Horton: The Soft X-Ray Absorption Limits of Certain Elements.—Prof. W. L. Bragg and G. B. Brown: The Crystalline Structure of Chrysoberyl.—H. G. Telling: On a Set of Quartic Surfaces in Space of Four Dimensions; and a certain Involutory Transformation.—L. F. Richardson: Atmospheric Diffusion shown on a Distance-Neighbour Graph.—T. Alty: Some Phenomena occurring at the Surface of Bubbles in Water.—A. L. M. Sowerby and S. Barratt: The Line Absorption Spectra of the Alkali Metals.—Prof. A. M. Tyndall and G. C. Grindley: The Mobility of Ions in Air, Parts I. and II.—W. Jevons: A Band Spectrum of Tin Monochloride exhibiting Isotope Effects.—J. H. Andrew, M. S. Fisher, and J. M. Robertson: Some Physical Properties of Steel and their Determination.
Linnean Society of London, at 5.—Prof. Fantham and Dr. Annie Porter: Two Protozoan Parasites in the Latex of *Ficus edulis* and *Euphorbia striata*.—Dr. H. Hamshaw Thomas: The Relations of the Caytoniales with the Modern Flowering Plants.
Royal Society of Medicine (Dermatology Section), at 5.—Prof. Levaditi: Les nouvelles découvertes dans la chimio-thérapie de la syphilis.
Royal Institution of Great Britain, at 5.15.—Prof. C. J. Patten: The Language of Birds.
Institution of Mining and Metallurgy (at Geological Society), at 5.30.
Institution of Electrical Engineers, at 6.—J. L. Thompson and H. Walmsley: Notes on the Testing of Static Transformers.
Royal Aeronautical Society, at 6.30.—Major J. S. Buchanan: The Schneider Cup Race, 1925.
Illuminating Engineering Society (at Royal Society of Arts), at 7.—E. Farmer and others: Discussion on The Lighting of Coal Mines.
British Astronomical Association (West of Scotland Branch) (at Royal Technical College, Glasgow), at 7.30.—J. D. M'Dougall: Planetary Orbits.
Optical Society (at Imperial College of Science), at 7.30.—R. Kingslake: The Interferometer Patterns due to the Primary Aberrations.—J. Guild: Demonstration of (*a*) a Trichromatic Colorimeter suitable for Standardisation Work; (*b*) a Vector Colorimeter, an Instrument Operating on a New Principle.—The Gaumont Company, Ltd.: (*a*) The "Trans-Lux" Daylight Picture Screen; (*b*) An Opaque Projector.
Institution of Automobile Engineers (Luton Graduates' Meeting), at 7.30.—C. E. Gritton: Epicyclic Gearing.
Institution of Automobile Engineers (London Graduates' Meeting), at 7.30.—L. F. Little: The Design of Light Alloy Pistons.
Institution of Electrical Engineers (Irish Centre, Dublin) (at Trinity College, Dublin), at 7.45.—A. P. Trotter: Illumination and Light (Faraday Lecture).
Chemical Society, at 8.—R. G. W. Norrish and G. G. Jones: Studies of Valency. Part VII. Surface Polarity and the Reaction of Ethylene and Chlorine. The Effect of the Adsorbed Water Layer.—W. Charlton, W. N. Haworth, and S. Peat: A Revision of the Structural Formula of Glucose.—Dr. J. G. F. Druce and F. H. Loring: Dvi-manganese.—R. Forsyth, V. K. Nimkar, and F. L. Pyman: The Nitration of Benzamidines.
Royal Society of Tropical Medicine and Hygiene (at 11 Chandos Street, W.), at 8.15.—Dr. Hasson: A New Procedure in the Diagnosis and Treatment of Leprosy.—Lt.-Col. W. P. Macarthur: Old-time Plague in Britain.
Institution of Mechanical Engineers (Manchester Branch), Annual Meeting.

FRIDAY, January 22.

Royal Society of Arts (Indian Section), at 4.30.—Col. W. M. Coldstream: Indian Maps and Surveys.
Physical Society of London (at Imperial College of Science and Technology), at 5.—Prof. T. H. Laby: A Critical Discussion of the Determinations of the Mechanical Equivalent of Heat.—F. I. G. Rawlins: The Present Status of Theory and Experiment relating to Specific Heat and the Chemical Constant.
Royal College of Surgeons of England, at 5.—Sir Arthur Keith: Fossil Remains of Ape and Man: (3) Ancient Dwellers in the Thames Valley.
Institution of Mechanical Engineers, at 6.—Prof. A. H. Gibson: Piston Temperatures and Heat Flow in High-Speed Petrol Engines.
Society of Chemical Industry (Chemical Engineering Group) (jointly with the Liverpool Section) (at Liverpool University), at 6.—Dr. E. B. Maxted: The Use of High Pressures in Chemical Industry.
Institution of Electrical Engineers (London Students' Section), at 6.15.—C. F. George: Switchgear.
Society of Chemical Industry (Glasgow Section) (at 39 Elmbank Crescent, Glasgow), at 7.—B. D. W. Luff: Modern Views on the Vulcanisation of Rubber.
Junior Institution of Engineers, at 7.30.—E. Granville-Smith: The Engineer and his Relationship to the Tea Industry.
Geologists' Association (at University College), at 7.30.—F. Gossling and S. W. Wooldridge: On Outliers of Lenham Beds at Sanderstead, Surrey.—A. G. Davis: Some Chalk Sections in N.E. Surrey.—N. L. Silvester: Glacial Features in a New Exposure at Finchley.—H. W. Cornes: Some Recent Sections in the Glacial Deposits of the Finchley Plateau.
North-East Coast Institution of Engineers and Shipbuilders (at Newcastle-upon-Tyne), at 7.30.—A. Campion: Cast Iron for Internal-Combustion Engines.
North-East Coast Institution of Engineers and Shipbuilders (Middlesbrough Branch, Graduate Section) (at Middlesbrough), at 7.30.—J. Miller: Electric Lifts.
Architectural Craftsmen's Society (at Royal Technical College, Glasgow), at 7.45.—D. L. Crawford: Architecture Past and Present in West Highlands.
Royal Institution of Great Britain, at 9.—Sir William Bragg: The Work of the Davy Faraday Research Laboratory.
Institution of Mechanical Engineers (Sheffield Branch Meeting).—A. V. Kemp: Modern Developments in Open Hearth and other Steel Works Furnaces.
West of Scotland Iron and Steel Institute (at Royal Technical College, Glasgow).—Dr. A. M'Cance: Open Hearth Practice.

SATURDAY, January 23.

Electrical Association for Women (at Æolian Hall), at 3.—Demonstration of the Application of Electricity in the Production of Music for the Home.—H. V. Spanner: The Place of Music in the Home (Lecture).
Royal Institution of Great Britain, at 3.—H. Balfour: The Evolution of Currency and Coinage.
Physiological Society (at National Institute for Medical Research).

PUBLIC LECTURES.

MONDAY, January 18.

University College, at 4.—H. Higgs: Some Social Problems in the Light of Economics and Statistics (Newmarch Lectures). (Succeeding Lectures on January 25, February 1, 8, 15, and 22.)—At 5.30.—M. H. Krishna: Indian Archæology and Anthropology. (Succeeding Lectures on January 25, February 1, 8, 15, 22, 26, and March 1.)
King's College, at 5.30.—Dr. F. A. P. Aveling: The Human Will: Greek Views.

TUESDAY, January 19.

University College, at 5.30.—Dr. E. G. Richardson: Acoustics of Buildings. (Succeeding Lectures on January 26 and February 2.)

WEDNESDAY, January 20.

Institute of Historical Research, at 5.30.—N. B. Jopson: The Earliest Civilisation of the Slavs. (Succeeding Lectures on January 27, February 3, 10, 17, 24.)
University College, at 5.30.—Justice Piggott: Insanity, Legal and Medical.—Prof. G. Elliot Smith and W. J. Perry: The Study of Man. (Succeeding Lectures on January 27, February 3, 10, 17, 24.)
Gresham College (Basinghall Street), at 6.—Sir Robert Armstrong Jones: Physic. (Succeeding Lectures on January 21, 22.)

THURSDAY, January 21.

King's College, at 5.30.—S. Smith: Early Arabian Tribes.

FRIDAY, January 22.

University College, at 4.30.—Prof. G. Spearman: Facts and Fallacies about Mental Tests.

SATURDAY, January 23.

Horniman Museum (Forest Hill), at 3.30.—Miss M. A. Murray: Europe's Debt to the Ancient Egyptians.