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Research in Agriculture.

Although the Development Commissioners are not themselves directly responsible for agricultural education and research during the last fourteen years, the manner in which the funds subject to the jurisdiction of the Commissioners have been portioned out has exercised a dominating influence on both the quality and quantity of scientific information that has been recently acquired, and on the nature of the organisation by which it has been sought to render this information of immediate assistance to the farmer. If the fourteenth Report of the Development Commissioners (H.M.S.O., 4*s*. net) is read in conjunction with the first and later reports, it will be noted that the Commissioners have favoured and adhered to a more or less definite policy from the outset. They realised that one of the primary needs was to assist in the training of men competent to conduct research, and then to accelerate research on the fundamental problems underlying agricultural practice. The body of scientific men at present employed in connexion with agricultural science is to-day vastly greater than it was fourteen years ago, and it is probably not too much to say that the average training which these men have received, and also the attainments and qualifications of the average man, are decidedly better.

It has been the policy of the Commissioners to add to the volume of research, chiefly by assisting in the initiation and maintenance of Research Institutes and Experimental Stations, and there are now about twenty such stations in Great Britain dealing with fundamental problems. It is interesting in passing to note that the necessity of having more than one institution to deal with certain problems which have specially local application has now been realised and acted upon; thus England, Scotland, and Wales has each a Plant Breeding Station aided by grants from the Development Fund, while the needs of horticulture, for example, are recognised at more than one institution.

The Report before us affords ample evidence of the quality and quantity of the research in progress at these institutions. It is beyond the scope of the present article to attempt to review this work. It is necessary, however, to lay emphasis on its fundamental character, the vast majority of the scientific papers for which the staffs of the institutions have been responsible dealing with difficult problems approached in an exhaustive manner and by purely scientific methods. There can, in short, be not the least doubt that the policy of the Development Commissioners has been successful to a marked degree in two highly important directions. To-day we have, comparatively speaking, a large, and in the main a well-qualified, body of agricultural scientific workers, and a vast mass of accurate scientific data of great potential value to the farmer and to the nation. No reasonable criticism can be levelled against the Commissioners for the manner in which the funds have been apportioned in relation to solving the problems of the various branches of the industry, although to some it may appear that horticulture has been treated more generously than would at first sight seem to be justified by its position in Great Britain. It has, however, to be realised that horticulture is an intensive industry employing a considerable amount of labour, and thus any extension of fruit culture or market gardening must immediately and inevitably react in a favourable manner on the rural population.

It is obvious that science cannot of itself redeem an industry which is in the main under-capitalised and very largely unprofitable. It should, however, be equally obvious that if the conference of land-owners, farmers, and land-workers recently convened by the present Government can in fact agree on a sound agricultural policy at once far-sighted and acceptable to the nation as a whole, the ultimate success of that policy will be largely determined by the extent to which science is brought to the direct aid of the farmer. It is, therefore, legitimate to examine the organisation which exists to-day for the explicit purpose of bringing science to the direct aid of the farmer, and to do so in the light of what are considered to be the chief necessities of British agriculture, if this industry is to be regarded as of national importance as well merely as of something which concerns the well-being of what is no inconsiderable proportion of our population.

The Commissioners have, of course, realised the necessity of a connecting link between the Research Institutions and the county organisers who are primarily responsible for advising the farmer as to scientific practices. Advisory officers are now attached to fourteen institutions; the majority of these are, however, advisory chemists and pathologists whose chief preoccupation in most cases is to undertake research on laboratory lines into problems of local importance, and in the main they have not the facilities to investigate farm practices as such. It is therefore satisfactory to note that Advisors in Economics are now being appointed at some of the institutions, and the work already done, notably at the University of Leeds, would seem to indicate that, particularly when the officers devote their attention to the economics of local practices, they are able to afford signal service to the farmers within their areas. Recent results obtained at the Research Institutes in the realm of animal nutrition have been followed up at college farms by accurate feeding trials, so that it is now possible for organisers who have had the opportunity of gaining personal experience to give authoritative advice to individual farmers, which has in innumerable cases revolutionised the system of feeding adopted. In this connexion the pioneer work of Mr. Boutflour in Wiltshire affords one of the best recent examples of the way in which science has been brought to the direct and very substantial aid of the farmer, and has incidentally caused increased production, in this case in terms of gallons of milk. It is perhaps open to doubt, however, whether science has been brought sufficiently to bear on some of the wider and more national aspects of agriculture in Great Britain.

Mr. Edward Wood, the Minister of Agriculture, in recent speeches and referring to the conference of those concerned in the industry he has convened, has emphasised the need of adding to the area under cultivation in Great Britain, not necessarily by merely thinking in terms of wheat alone, and he has directed attention to the paramount need of making our more derelict lands fertile and this whether particular areas are left in grass or brought under the plough. Mr. Wood has also directed attention to the serious disadvantage under which the farmer labours in regard to bringing his farm into a higher state of fertility as the result of paucity of readily available working capital.

Broadly stated, then, one of the first necessities, if we are to have a healthy agriculture, is a campaign of land improvement in the widest sense, and from the facts of the case, no matter whether credit facilities are to be afforded to the farmer on a large scale or not, the improvements must be effected on an economic basis.

Here, then, is a concrete, yet highly composite problem, a problem towards the solution of which agricultural science has admittedly accumulated a vast array of data. But the items contributing to such data are largely unrelated and cannot at present be said to constitute a definite and trustworthy practical doctrine.

The allied questions of improving poor land and generally enhancing the fertility of farm lands in Great Britain as a whole are not subjects upon which the organiser can easily persuade the farmer himself to experiment. The problems involved entail, first, difficult economic considerations, and secondly, the elucidation of practical difficulties connected with the type of rotation and systems of cropping most suitable, methods of tillage, processes of manuring, relation of grass to arable, and the choice of the correct varieties and strains of crops. The general problem is not, moreover, one that is likely to be adequately dealt with at an institutional farm; for one thing, these farms are frequently of a higher grade than the average of the district which they represent, and for another, it is usually the policy to run such farms in conformity with the generally accepted canons of good husbandry.

Indirectly, valuable work has been accomplished in the direction of surveying the field by the various soil and other surveys that have been undertaken. Hitherto, however, no large sum of money has been set aside for this important work, which has been conducted in a somewhat haphazard manner and in many cases without critical regard to economic considerations. In any event, it is work that needs to be conducted on a well-thought-out and uniform plan, under the general supervision of a strong co-ordinating authority. The need of a complete agricultural survey showing both actualities and potentialities was rendered abundantly manifest during the War, while if a real endeavour is to be made to stabilise the industry and add to the productive capacity of farm lands in Great Britain, the non-existence of such a record will again be acutely felt.

In so far as growing the correct varieties of the chief crops is concerned, it is satisfactory to learn that a grant has been made to the National Institute of Agricultural Botany to enable that organisation to conduct subsidiary trials at carefully selected sub-stations. It is, however, on the poorer and more improvable types of land that variety trials are most needed, while in many cases the type of varieties necessarily handled by the National Institute are not likely to be those best suited to land of the lower productive classes. Trials of a somewhat different nature should also be initiated; the aim in the first place would be to discover the degree of productivity of every characteristic district, by setting up a series of properly replicated plots of the same standard variety—of a crop of wide-spread distribution such as oats—on as many farms as possible.

This is a procedure that should constitute an important feature of any general scheme of agricultural survey that may be set on foot, for without some really trustworthy quantitative and easily comparable crop data of this sort it is difficult to see how the results of surveys based on soil and other environmental factors can be interpreted to proper economic advantage. In the second place, it is exceedingly important to know the range of applicability of new and improved varieties, and it is just as important that the greatest possible number of farmers should be given the opportunity of forming their own opinion of such varieties.

With a view to these ends quantitative data are not necessary, or at all events not necessary in the first instance. A strip of, say, Yeoman wheat should be sown on a few fields in every parish in the country in which wheat, in no matter how small quantity, is grown. The same would apply to, say, Black Bell III. and Victory or Crown oats, while in particular districts it would be easy for the appropriate advisory centres to make proper suggestions as to varieties demanding extensive trials by this means. A similar simple method would make it possible rapidly and accurately to define the areas capable of successful lucerne cultivation, to establish the relative merits of widely different strains of such a fundamentally important crop as red clover for widely different habitats. All of these are problems of first-rate importance in relation to profitable land improvement.

More urgent than trials of the character indicated above is the necessity for conducting experiments in the realm of systems of cropping, and the relation of temporary to permanent grass, which would entail equally far-flung but more elaborate and long-continued field trials.

It is true that financial support has been given to further the idea of arable dairy-farming, and that the utilisation of barren sandy land has been under tentative investigation, but these are isolated aspects of the broad question of enhanced crop production and land improvement. They are not so much the province of agricultural chemistry or of agricultural botany as understood in Great Britain, but rather of field husbandry or agronomy as understood and investigated in the United States of America, for example.

Notwithstanding the work that is in progress in many important directions influencing land improvement, it is probably not too much to say that the problems of field husbandry will not be solved until an *ad hoc* organisation is set up to deal with the matter in a manner analogous to that in which the Research Institutions deal with the fundamental problems of plant breeding and animal nutrition, for example, or the way in which the advisers in agricultural chemistry deal with their local problems. It is doubtful, however, if a single Research Institute of field husbandry would adequately meet the case—numerous sub-stations would certainly be a necessity. It is, however, the principle that field husbandry is not at present a matter of demonstration, but is essentially a matter demanding field investigation of a most rigorous and accurate character, conducted without bias and in a true spirit of research, that must be realised. Two things are essential, namely, a co-ordinating authority and the appointment of men in the counties backed with facilities for conducting field investigations on carefully selected areas. A useful beginning could undoubtedly be made if advisers in field husbandry were appointed at institutions serving backward and infertile districts, while co-ordination could be assured by the appointment of an officer at the Ministry of Agriculture charged with the supervision of the work as a whole. It is probable that in some cases suitable land could be taken over for experimental purposes from the not inconsiderable areas now under the control of the Forestry Commission, while it is more than likely that land-owners and farmers would be found in very appreciable numbers who would be willing to assist in such an important undertaking.

Human Geography.

Human Geography: an Attempt at a Positive Classification—Principles and Examples. By Jean Brunhes. Translated by Prof. I. C. Le Compte. Edited by Isaiah Bowman and Prof. Richard Elwood Dodge. Pp. xvi+648. (London, Calcutta and Sydney: G. G. Harrap and Co., Ltd., n.d.) 21*s*. net.

THE student of modern geography by whom this classical work is read for the first time, might well feel that even in the few years, little more than a decade, since the original issue, most of this manual has become, if not out-of-date, at least somewhat antiquated. A youthful applicant for a situation was asked "Where is Tokyo?" He replied, "I do not know." The employer expressed his astonishment in vigorous terms, and the youth continued, "But if you will tell me where it is, I will tell you why it is there." This youth was a product of his period; the geography of to-day seeks to answer the question "why?" The aim of modern geography is to probe, to evolve generalisations, to eliminate and thus simplify complex phenomena in which the psychological factor is of supreme importance.

M. Brunhes provides a useful corrective. He writes and argues about what he has seen; he aims at a manual, not a treatise, at a collection of observed facts, not an explanation. Again and again he advises caution. The fundamental fact is place-relation, and he shows repeatedly how every thinker whose subject-matter implies some form of human activity needs the geographic sense. The Ricardian law of diminishing returns does not apply where the land, as such, is not the fundamental basis of property. Again and again the reader is referred to six essential facts: houses and roads, cultivated fields and domestic animals, exploitation of minerals and devastation in plant and animal life—facts familiar enough under a slightly different grouping of ideas in the terms shelter, food, and communications.

By numerous illustrations and digressions the reader is led to an idea of geographic method, to a manner of attack upon a seemingly heterogeneous collection of an apparently endless mass of isolated facts, and the whole outlook may be summarised under the query "how?" not "why?" A heavy snowfall is to be expected in January in New York and other places where the mean January temperature is about, or below, freezing point. The "why" of this fact belongs to the domain of physical science: the recognition of the fact as a possible factor in regard to man's life on the earth belongs to physical geography. So far everything is simple, but the human geographer asks the question how is man affected? It is his business to find out how man reacts to this circumstance, and he finds widely different answers for different parts of the world. The response in New York is different from the response in Italy, and so he arrives at the fundamental concept of location, the tyranny not of Nature as a whole but of place-relationship within Nature.

M. Brunhes is deliberately didactic; he teaches by selected samples and begins with the simplest examples. The easiest studies refer to islands—not only the real islands of the sea, but also the land islands where a community is relatively isolated by physical circumstance; his study of the Balearic Isles leads to thoughts about Java or Japan. Herein, it would appear, lie the elements of age which might repel the modern student, for there is little consideration of the world as a whole; there is no room for the current broad generalisations which underlie the idea of the "major natural regions of the world." A regional synthesis, however, is not lacking. A map of Spain, for example, shows within the area of dry Iberia five regions of steppes and irrigation, and so illustrates a regional classification based, not upon the facts of climate, but upon the ways in which man has responded to one particular element, water supply.

In the last chapter it is argued that space, distance and difference of level are fundamental geographical facts which are becoming more and more the sovereign masters of men, and the final conclusion is reached that "Every people . . . covers the surface of the earth with those outward and visible signs . . . which allow us to divine its past and sometimes even its future." Whither does all this lead? Apparently to the notion that geography is not a science, not an ordered body of knowledge, which is independent of the personality of the investigator, not a set of conclusions which must be universally valid, not a statement of generalisations valid for all time or for every place, but primarily and fundamentally a discipline, an outlook on man's life on the earth, which gives to the thinker that unique geographic sense so invaluable for the law-maker, the captain of industry, and the merchant prince, so useful a corrective in all matters which pertain to the conduct of human affairs on the large scale.

Whatever view may be taken, it must be confessed that the facts of geography are stubborn; they cannot be melted in the mental furnace and run into set moulds; they frequently misfit the theories: but the spirit of geography is of unique value. No other human study permeates so many of the sciences: no other study is so necessary to the equipment of the educated man.

Optical Measuring Instruments.

Optical Measuring Instruments, their Construction, Theory, and Use. By Dr. L. C. Martin. (Applied Physics Series.) Pp. ix+270+8 plates. (London, Glasgow, and Bombay: Blackie and Son, Ltd., 1924.) 17*s.* 6*d.* net.

"OBTAIN a measurement, however rough; then endeavour to get a better," was the advice that Lord Kelvin used to urge upon his students. Quantitative analysis is the natural supplement of qualitative reasoning. One rough estimation may serve to exclude a multitude of suppositions; one precise measurement may serve to indicate the definite conclusion of an investigation. But to make a measurement, even an approximate one, is not always easy. Precise metrology is a difficult art. It demands an understanding of the problem; access to the requisite apparatus or, failing instrumental means, the capacity to design and, if necessary, construct whatever appliances may be required; skill in their adjustment and use; and, above all, the will to discard the obvious, which in metrology is not always the truth.

As there is no superfluity of literature devoted to this particular subject, any new contribution, such as Dr. Martin's work on "Optical Measuring Instruments," will surely be welcomed. As the author has stated in his preface, "The selection of instruments for description is extremely difficult." It is unlikely, indeed, that from the great mass of material that is nowadays available the same selection would be made by many. With the exception of Chap. vii. devoted to rangefinders, it would appear that instruments of warfare have intentionally been rigorously excluded. All the appliances cited have an essentially peaceful character. They comprise measuring microscopes, micrometers, comparators, the divided circle, theodolites and sextants, levels, spectrometers, refractometers, spherometers, focometers, photometers, and saccharimeters. In the final chapter, "Errors and Accuracies of Observation" are discussed rather more briefly than the importance of this question would warrant.

There is a similar brevity in the presentation of the general principles forming the subject of the first chapter, where the author in his discussion of the principles of geometrical supports is to be congratulated upon his emphasis on the importance of the physical conditions. These first and last chapters might well have been extended at the expense, if necessary, of other sections. For example, although the divided circle is a highly interesting precision tool, it is scarcely an optical instrument when stripped of its reading microscopes, which are dealt with in the preceding chapters. Rangefinders, which are essentially militaristic in character and of correspondingly limited interest, might also have been excluded, if thereby space could have been provided for a chapter upon that premier optical instrument of supreme accuracy—the interferometer, which has been brought in Great Britain to so high a standard of perfection. The chapter on the rangefinder, and particularly the stereoscopic portion, is the least satisfactory section of the book. Evidently the author is unaware that the German claim which he emphasises on p. 121 has been disproved beyond doubt as the result of extensive trials made by most of the principal powers interested in this subject, and that many important gunnery officers of the German Navy no longer accept it.

Dr. Martin's book has the merit of originality. It is not a compilation from other works. Originality in a first edition demands, however, particular care in the avoidance of errors, and unfortunately there are throughout this book mistakes of so obvious a kind that it is difficult to understand why they should have escaped correction. In Fig. 45, which illustrates the application of an inverting prism to a sextant, the rays are quite incorrectly traced, as they are not shown touching the reflecting surface which determines the inversion of the image. All three diagrams of Fig. 93 are also incorrect. A ray normal to the surface of the prism (*a*) is shown refracted. In the next diagram, representing the same prism, the ray entering as before at scraping incidence is now shown refracted away from the base, the refracted ray within the dense flint prism being shown in an impossible position. According to Fig. 93 (*c*), a beam of light passing through an equivalent plane parallel plate is wrongly represented as suffering severe refraction instead of emerging parallel to its original direction.

The mistakes are not confined to the illustrations: they occur also in the text. As an example, the "special problem in angular measurement" at the end of the chapter on theodolites and sextants may be cited. The problem indicated is to measure the inclination of two lines. It is proposed, instead of suitably rotating the cross-wire of a telescope with reference to the lines and a scale, to make use of a rotatable inverting prism. As the author states, if such a prism is rotated about the direction of view, the inverted image rotates at twice the angular speed of the prism, and the conclusion is arrived at that greater accuracy of measurement is attained by these means. But, as the problem is the measurement of a particular angle, the prism will require to be rotated through only half the angle to be measured, and the comparative accuracy will accordingly be halved.

Although the majority of the mistakes are obvious ones, they may prove confusing to a thoughtful student, and more careful revision, particularly of the illustrations, is desirable in any future edition of the work.

JAMES WEIR FRENCH.

Sands and their Uses.

Sands and Crushed Rocks. By Alfred B. Searle. (Oxford Technical Publications.) Vol. 1: *Their Nature, Properties and Treatment.* Pp. xiv+475. Vol. 2: *Their Uses in Industry.* Pp. ix+281. (London: Henry Frowde and Hodder and Stoughton, 1923.) 52*s.* 6*d.* net.

MR. SEARLE has made an attempt to fill a gap in technical literature by a work which deals, in all aspects, with the subject of sands and crushed rocks. According to the author, the purpose of the work is "to summarise in a convenient form such geological, chemical and mineralogical information on sands as is likely to prove of value to those engaged in the digging, sale, and many uses of these materials." To the reviewers, however, it seems that the author's enthusiasm for detail, much of which appears irrelevant, has defeated this purpose.

A glance at the table of contents will reveal the varied nature of the material gathered together in Volume 1. Commencing with the origin and formation of sands, we finish with a chapter on their storage, packing and despatch. In Chap. iii., ninety pages are devoted to a catalogue, arranged in alphabetical order with descriptive detail, in which names are given to nearly one hundred and fifty sands! For no obvious reason, a description of a carborundum furnace is here included. Incidentally, there seem to be but few substances which, according to the author, do not come within the purview of this subject. For example, ground glass and metal filings are stated to have been used as "sands" in concrete, while "breeze" is described as an artificial sand consisting of sifted ashes. The writer has departed considerably from the customary definition of a sand as a natural, detrital and non-plastic deposit. Chap. iv., written on similar lines, deals with some of the mineralogical constituents of sands, while in the next two chapters their properties, as well as their examination and testing, are described.

The remainder of this volume is concerned with the treatment which sands and sand rocks undergo before use. It is profusely illustrated, but many of the photographs are reminiscent of the advertisement catalogue.

The second volume of the work enlarges upon the uses of sands and crushed rocks in industry. The uses of these materials in brick-making, in road construction, as refractory materials, in agriculture, in glass-making and in metallurgy, to mention only a few of the more important applications, all receive attention.

Many statements to which exception may be taken seem to have escaped the author's notice. For example, Stokes's law is first written as $V=\frac{2D-d}{9z}$ and then quoted correctly on the next line. Referring to the constant weight obtained when a material has been fully dried we find the statement that "this weight, less that of the bottle and contents previous to drying, is the amount of moisture in the weight of materials used." In connexion with electrostatic separators, we are told that "a still more definite separation will take place if the whole of the material is first charged negatively and is then brought into contact with a positively charged body," while it is also stated that the "mean coefficient of expansion of silica between 0° C. and 1000° C. is 0·68." Again, the figure on p. 437 (I.) given in illustration of a "gas-fired" furnace does not represent a gas-fired furnace. Finally, we are told that "a tunnel-kiln efficiently insulated with kieselguhr on the sides and roof can usefully employ 98 per cent. of the available heat in the fuel."

Elsewhere, there becomes apparent a certain looseness of style, and this gives rise to statements which may be ambiguous or often misleading. For example, the refraction of light is described as the *turning* of a ray of light, while on p. 208, Vol. 1, it is explained that doubly refracting materials "turn a ray of white light through several different angles, so that the rays are termed ordinary and extraordinary rays."

Moreover, the book contains inconsistencies, one example of which cannot be allowed to pass unnoticed. "Tridymite bricks are silica bricks in which the whole of the silica has been converted into tridymite. . . . No brick on the market consists entirely of the low specific gravity forms of silica."

The breadth of field which the subject covers, the inaccessibility of many publications, and considerations of space, are put forward in the preface as a plea for the omission of full references. But surely the time has come when few technical or scientific works, other than the most elementary, can stand the test of publication without the support which adequate references to the literature of a subject gives. The necessary space could have been gained by the elimination of much of the unnecessary matter and by avoiding repetition.

A judicious selection of the references the author must have accumulated during the many years in which, as he tells us, he has read the leading journals on the subject, would undoubtedly have enhanced the value of this book and been of permanent worth.

The volumes are well printed and well presented, but the price is high, and the author would have done well to have compressed his subject-matter into a smaller space. Doubtless much useful information will be found, especially in the second part, by those for whom the author has written, but the gap in the literature still remains.

L. S. T.
W. E.

An Oxford Sketch of the Evolution of Thought.

Speculum Mentis, or the Map of Knowledge. By R. G. Collingwood. Pp. 327. (Oxford: at the Clarendon Press, 1924.) 12*s.* 6*d.* net.

MR. COLLINGWOOD has a tradition of art behind him and he has also made himself recently one of our leading authorities, if not the first of all, on Roman Britain. As he adds to this a profoundly philosophic mind, his attempt in this book to survey the whole field of human thought has some material for its foundation. It is modest in expression though ambitious in scope, and will interest greatly those who like to trace a line of thought faithfully pursued by a thinker who wrestles hard with every conclusion, and gives the public nothing but what he has won from his own experience, intensely felt.

The general thesis of the book is that the human mind, whether in the individual or in the race, passes through a series of experiences each of which is incomplete and partially corrected by the succeeding stage, until it rests at last in a philosophy of absolute or final worth based on the mind itself, enlightened by history. It will be seen that there is a large heritage from Hegel here, and if one wished to describe the point of view in terms of older thinkers who have influenced the writer, one would say that it was Hegelianism plus Croce. But this would do scant justice to Mr. Collingwood's sincerity of thought and striking individuality. One appreciates the book most as a personal revelation.

Art is the first, and always the primitive, stage of thought; and this passes into the kindred, concrete and unanalysed stage of religion. Analysis, when it comes, gives us science, which appears in Mr. Collingwood's hierarchy of thought as the middle term. Art and religion are below or before it: history and philosophy above or after. We are not to imagine that the lower stages are entirely superseded by the higher; they are rather corrected and subsumed in a fuller point of view.

The use that Mr. Collingwood makes of the recent historical spirit in science is very apt and enlightening. It is the clearest and most conclusive part of the whole book. During the nineteenth century many of the sciences, as he tells us, restated their problems in terms of history. Astronomy realised that its proper task was to explore the history of the stellar universe; geology and geography united to study the history of the earth, and biology came to see that the problem of species is the problem of the origin of species. "The time seems near at hand when science will feel the need of absorbing itself bodily in history and re-shaping its problems throughout in historical terms."

This passage from science to history is one of the numerous points in the book where a penetrating light is thrown by the author's synthetic and persevering thought. He might perhaps have made his effect better by a little more compression. There is a good deal of repetition, and the reader himself needs perseverance; but he will be richly rewarded. It is one of the most profound and suggestive treatises of recent years.

F. S. Marvin.

Our Bookshelf.

The Design and Working of Ammonia Stills. By P. Parrish. Pp. 300. (London: Ernest Benn, Ltd., 1924.) 40*s.* net.

Three hundred thousand tons of ammonium sulphate are produced annually in Great Britain by the direct distillation of the ammoniacal liquors arising from coal and shale products. Even from this consideration alone, the publication of the first standard comprehensive book in English on the design and working of ammonium stills must be regarded as an event not only of scientific but also of economic importance. Many chemical manufacturers in the past for various reasons have endeavoured to keep their processes strictly secret, and improvements have come from internal experience on the plant rather than from general physico-chemical considerations or from a combined study of the theoretical and applied aspects of the problem or difficulty encountered. "Collaboration," Dr. Charles Carpenter notes in the preface, "between those responsible for the design of large-scale chemical plant can only be a war-time measure." Mr. Parrish will help to some extent to remove in one industry this individual outlook and veil of secrecy, for in his book he has collected together a great amount of novel information of a fundamental and authentic character on the subject of ammonia stills and accessory plant. This carefully-edited book, which includes 170 excellent illustrations and 70 technical tables, must benefit the industry generally and secure a common outlook for new developments on other than empirical lines.

It is indicated that the greatest economy in the manufacture of ammonium sulphate is likely to accrue from a better utilisation of the available heat of the process, and the aim of the author has been to show how this can be achieved. In fact, so keenly has the point been emphasised that the volume might be called the design of ammonia stills in relation to steam economy and the utilisation of potential heat. The fundamental principles underlying the design of stills, preheaters, condensers, dephlegmators and coolers all receive thorough consideration in this connexion. The opinions put forward are those of a successful works' chemist who writes more particularly for the benefit of other gas chemists and engineers rather than for the guidance of the chemical student.

A note of criticism might be made on the general use of chemical formulæ in a somewhat loose manner, while the chemical equations given are not always correct.

In conclusion, it should be stated that the financial aspect of the subject of ammonia distillation also receives detailed treatment, and the author makes every effort to indicate the economic soundness of processes under particular conditions.

JOS. REILLY.

The Subject Index to Periodicals, 1921. Issued by the Library Association. *B-E: Historical, Political and Economic Sciences.* Pp. 106. 21*s*. net. *F: Education and Child Welfare.* Pp. 28. 4*s*. net. (London: Grafton and Co., 1924.)

WE welcome these two sections of the Subject Index to Periodicals published by the Library Association. They maintain the high standard attained in previous sections of this catalogue. These sections index papers published in 1921, so that the Association is now allowing a little less time to elapse between the date of publication of the original papers and that on which the Subject Index is issued. It would, of course, be more useful to those engaged in scientific work if it were found possible to shorten the interval to somewhat less than three years, and the Library Association will, no doubt, when it has overcome all the difficulties connected with a work of this kind, find it possible to issue its Indexes within a period of two years from the date of publication of the periodicals indexed.

Among those subjects in the section on historical, political and economic science to which particular attention has been paid we notice agriculture, banks and banking, bolshevism, chemical manufacturers, coal trade, co-operation, the Eastern question, employees and employment, ethnology, the European War, fisheries, forestry, international law, labour, mines, railways, shipping and wages.

The section on education and child welfare will be of great value to those who are devoting themselves to the study of these subjects. An examination of the 54 columns of titles of papers in this section will show the direction in which the thoughts of those advocating reforms have been chiefly turned. We note especially educational psychology and mental tests, and papers on the position of teachers. Papers on the teaching of citizenship are grouped together, as are also those on abnormal and backward children. The question of classical education has, of course, a heading to itself. Papers coming under the general head of education occupy nine columns of the Index, but these are subdivided under various subheadings which make reference easy. There are also headings for science study and for technical education.

Thysanoures, Dermaptères et Orthoptères de France et de la faune européenne. Par Prof. C. Houlbert. (Encyclopédie scientifique: Bibliothèque de Zoologie.) Tome 1. Pp. xii + 382. (Paris: Gaston Doin, 1924.) 16 francs.

THIS clearly written and well-arranged little volume forms a handy and up-to-date work of reference to the orders of insects concerned. The longest section (Part I.) is devoted to the Apterygota or, as Prof. Houlbert prefers to term them, the Thysanura. These he divides into the two sub-orders Collembola and Monomorpha (Thysanura of most authorities). It is prefaced by a general account of their structure (based largely upon the work of Willem), and there follows an exceedingly useful series of family and generic keys, along with descriptions of the various species. This section of the volume should appeal to many entomologists since it provides a readily accessible guide to the insects of those two orders. The work of Lubbock has long been out-of-date, and the student has hitherto had to rely upon various scattered memoirs (some not easily procurable) for the identification of his material. Part II. deals in a similar manner with the Dermaptera, and Part III. is devoted to the general structure and habits of the Orthoptera, descriptions of the species of the latter order being reserved for a second volume. The book is fully illustrated and has ample bibliographical references.

A. D. I.

A Comprehensive Treatise on Inorganic and Theoretical Chemistry. By Dr. J. W. Mellor. Vol. 5: *B, Al, Ga, In, Tl, Sc, Ce, and Rare Earth Metals, C,* (Part 1). Pp. x + 1004. (London: Longmans, Green and Co., 1924.) 63*s*. net.

THE new volume of Dr. Mellor's Treatise includes boron, aluminium, and the rare earth metals, together with a considerable part of the section on carbon. The style and general method of treatment are similar to those used in the earlier volumes and do not call for any comment. Perhaps the most striking feature of this volume is the treatment of the complex compounds of boric acid. Some of these can only be expressed by formulæ such as $KMg_2B_{11}O_{19}$, $9H_2O$, $Mg_7B_{16}O_{30}Cl_2$, or $Cd_5\{H_4[B(W_2O_7)_6]\}_2$, $51H_2O$, and would certainly be omitted from any elementary text-book; but they all find a place in the comprehensive treatise of the author, just as readily as if their compositions could be expressed by formulæ of the simplest kind.

The "Chemical Age" Chemical Dictionary: Chemical Terms. Pp. 158. (London: Ernest Benn, Ltd., 1924.) 16*s*. net.

THE dictionary gives the definitions and in many cases short descriptions of a large number of terms used in chemistry. Practically all branches are covered, and the book is up-to-date. A few sections, taken at random, were: deanimation, hæmacytometer, isomerism, oligodynamic action, quinocarbonium, thermodynamics, ultramicroscope, and X-ray analysis, and in each case a clear and accurate account of the topic was presented. The book should prove useful to technical journalists and for general reference, as well as to chemists.

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.*]

Resonance Radiation and the Correspondence Principle.

THE experiments of Wood and Ellett [1] on the polarisation of the resonant radiation of mercury suggest that it is necessary to make a rather important modification in the quantum theory. The theory of the phenomenon has been examined by several writers,[2] among whom Eldridge has most explicitly directed attention to a case of difficulty. He shows that the observations in a magnetic field are a natural consequence of regarding magnetism as equivalent to rotation, provided that the effect without field is given, but that this effect without field conforms rather to the classical than to the quantum theory.

This is the difficulty. Suppose light of wave-length 2537 Å.U. going northwards and polarised with electric vector in a vertical plane—the points of the compass are merely used to describe relative directions. If this light falls on mercury vapour, an observer to the east sees the resonant light almost completely polarised in a vertical plane, and one above sees practically no light at all. The wave is that which, on the classical theory, would be emitted by an electron vibrating in a vertical line; it may conveniently be called a *linear* wave, and similarly the wave emitted by an electron revolving in a circle may be called a *circular* wave. According to the quantum theory, the resonant line of mercury is associated with a change of angular momentum, and so each atom should emit a circular wave. There is little known in the quantum theory about the process of excitation, but as the electric force is vertical it is natural to suppose that it would give the atom angular momentum about some horizontal axis. However that may be, the radiations from the separate atoms are not coherent, and no possible combination of incoherent circular waves can give rise to a linear wave.

Some sort of explanation could perhaps be constructed by supposing that the electric force in the incident light itself orientated the atoms, and that the resonant radiation was controlled by a Stark effect. This does not really remove the difficulty, for if the vapour were illuminated by circularly polarised light the atoms would have continually to re-orientate themselves, and at such a rate that the concept of the angular momentum of the atom would lose all meaning. The plain fact is that we are dealing with a "degenerate" system, and the degeneracy is of a new kind, exhibiting itself externally and not merely as a purely conceptual question. Any explanation has to face the fact that the atoms are orientated arbitrarily. Since they react to the light in a manner independent of this arbitrary orientation, we must suppose that each single atom is somehow much more isotropic than would be admitted by the ordinary Bohr model. This isotropy might perhaps be attained by supposing the process of excitation to be so slow that the atom passes through all phases of its motion before it is complete.

[1] Wood and Ellett, Proc. Roy. Soc. A, ciii. p. 396, 1923.

[2] Breit, *Phil. Mag.*, xlii. p. 832, 1924; Gaviola and Pringsheim, *Ztschr. f. Phys.*, xxv. p. 367, 1924; Eldridge, *Phys. Rev.*, xxiv. p. 234, 1924, and others.

The correspondence principle was formerly enunciated as a rather precise rule by which the results of classical mechanics could be transferred into the quantum theory. There has, however, arisen a tendency to take it in a wider and vaguer sense, as a statement that to any suitable classical theorem there will be an analogue in terms of quanta, and the remaining difficulty is the decision of what theorems are suitable. The present phenomenon strongly suggests a well-known theorem which has not yet been used. A mechanical system vibrating about a state of equilibrium or steady motion usually possesses a unique set of normal modes of vibration, but if some of the frequencies are exactly equal, the modes become ambiguous. Thus a particle vibrating in a plane with equal frequencies for the two directions can describe not only right- and left-handed circles, but also a straight line in any direction. If we apply the correspondence principle to this theorem, it says that if an atom can emit circular waves of equal frequency in either sense, then it can also emit linear waves. We are applying in quite a different branch of the subject Bohr's view of degeneracy; compare it, for example, with his view that in ordinary elliptic motion the eccentricity is not to be quantised, but may have any value.

The accepted form of the quantum theory does not, of course, admit that the same atom can emit both types of circular wave from a given stationary state, but we have seen that it fails to explain the resonance, and the present suggestion is the most natural, if not the only one, which can do so. It must be remembered that there is no direct evidence at all for the emission of purely circular or linear waves from the single atom in the absence of a magnetic field. When there is a field, the degeneracy disappears, the frequencies become unequal, and our theorem is replaced by the straightforward quantum explanation.

There is no avoiding the fact that the theorem has an effect on the quantum theory which is absolutely devastating. Thus there is a failure of all the arguments concerned with the angular momentum of the atom, and therefore of the physical reality of the Bohr orbits. It must, however, be noticed that an idea is entering which is new to the quantum theory, for as the atoms are arbitrarily orientated, the phenomenon requires a definite statement of *phase*. In all previous cases the various linear and circular waves have had unequal frequencies, and so no question of phase arose. There seems to be no reason to give up the concepts connected with angular momentum so long as they are confined to non-degenerate systems or to degenerate systems in which the character of the degeneracy is not studied, and we may expect great further progress by their use. But these concepts are to be regarded, not as ultimate reality, but as a convenient short-cut to the study of complicated systems, and the correspondence principle ought to be applied to the more formal and less physical description of the atom. It is not surprising that the older theory should fail over resonant radiation, for it has shown a complete inability to deal with the other important problem in which phase plays a part, the refraction of light.

It is perhaps possible to argue that a modification might be made in our conceptions of emission without disturbing our ideas of the quantised orbits of the electrons. Even this is not without difficulty, though perhaps it is less insuperable. We have to suppose that the atom is raised to its p-state by the action of the electric force, and that it remains there for a time of the order of 10^{-8} sec. During this time the precessions and apsidal motions of the electrons will be very large indeed, and it is difficult to see how the atom could, so to speak, remember for so long the axis of the wave it is to emit. Angular momentum would have furnished such a "memory," but the electric force can contribute none about the proper axis.

The discussion is not complete without considering sodium vapour and other substances,[3] but it would take too long to discuss them here. On account of the multiplicity of levels in a magnetic field the effect is more complicated, and the quantum theory is conspicuously successful in explaining the imperfect polarisation, but the difficulty with no field remains outstanding and seems to require the same hypothesis as does the more extreme case of mercury.

May I take this opportunity for a word of personal explanation? At the time that Wood and Ellett were doing their experiments, Prof. Wood very kindly communicated them to me and asked me for an explanation of them. I wrote this back to him in a rough form, making use of a trigger idea for the excitation. I was only regarding this as a quick way of using the classical theory without introducing the fundamental difficulties which lie at the root of it, but I had no opportunity of casting the explanation into a more conventional form in accordance with that theory. I must confess I also had the impression that it would go as well in terms of quanta, but I certainly had no idea either of the special success which would attach to the cases of sodium, etc., or of the difficulty which is the subject of the present letter.

C. G. DARWIN.

The University, Edinburgh,
January 2, 1925.

[3] Ellett, NATURE, December 27, 1924, vol. 114, p. 931.

Transmission of Stimuli in Plants.

IN an article in NATURE of October 25 Prof. Dixon [1] has reviewed an investigation of conduction in *Mimosa pudica* which I lately carried out in Trinidad.[2] He agrees with my conclusion that "normal" conduction in the stem has been correctly explained by Dr. Ricca as depending on a stimulant moving with the transpiration current in the wood, but disagrees in that he inclines to consider that Dr. Ricca's explanation is adequate to cover *all* the phenomena of conduction in Mimosa, including conduction in the leaf and the subordinate phenomenon of "high-speed" conduction in the stem. He offers no positive evidence tending to support this view, but criticises the evidence from which I have concluded that Dr. Ricca's explanation will not cover the whole ground.

This autumn, working on *Mimosa Spegazzinii* in Sicily, I have obtained further evidence which confirms my previous conclusion, and provides an answer to several of Prof. Dixon's criticisms, with most of the remainder of which also I am unable to agree. It was found, for example, that in the leaves of cut shoots that had been totally submerged under water for two or three hours, excitation was conducted in both directions considerably *more* rapidly than in similar leaves in air and still attached to the plant. Yet in the stems of such shoots, the velocity of the transpiration current, as measured by ascent of stain, was reduced to about 1 cm. per minute, as against a rate of about 5 cm. per minute in shoots with their leaves in air.

Again, the experiment was repeated of cutting off the tips of leaves under a stain. Previously it was found that in most cases the stain failed to enter the vessels at the leaf tip. The explanation may be that the vessels in some way got blocked, as Prof. Dixon suggests—a possibility that ought certainly to have been taken into account before. But this time the leaves were so manipulated that the stain always entered the vessels. It was, however, sucked back down the leaf at the rate of from 1 to 2·9 cm. per minute only, while in the same leaves at the same time excitation was conducted down at speeds from 6 to 12 cm. per minute.

Similarly, in detached leaves that had stood for some hours with the base of the petiole in water, the rate of ascent of stain was only from 1 to 2 cm. per minute, while at the same time excitation was conducted up them at speeds from 6·2 to 16 cm. per minute. The movements of water in the vessels cannot, therefore, account for excitatory conduction even in the leaf of *M. Spegazzinii,* in which it is much less rapid than in the leaf of *M. pudica*. The results also show that in the leaf the transpiration current ascended much more *slowly* than in the stem, whereas excitation, in *M. pudica* at least, is conducted far more rapidly in leaf than in stem. The details of these experiments it is intended soon to publish.

With regard to Experiment 11, in which all the wood was cut through in the petioles of leaves of *M. pudica*, Prof. Dixon says that it is hard to see why excitation could not have been conducted down by a stimulant passing down the wood and crossing the watery gap. The reason is surely clear. In order to explain basipetal conduction in the leaf by movements of water in the wood, it is necessary to suppose, as Dr. Ricca and Prof. Dixon have supposed, a state of tension in the water columns, which is released by cutting the leaf tip. But in this case, the cut in the petiole had opened up all the vessels to the surrounding water in which the cut was submerged all the time, so that no adequate tension can have existed. It is, therefore, impossible that a stimulant in the water columns should have been sucked back even down to the cut, let alone passing it, as did the excitation, and reaching the main pulvinus, a total distance of about 7 cm., in 3½ seconds. It can only have travelled by the phloem. The conditions were absolutely different from those in the "discontinuity" experiments on the stem, in which a water-tight joint was made between the two portions of stem, in order that the stimulant might be sucked over from one to the other. Moreover, it was pointed out that the next experiment (Expt. 12), which Prof. Dixon does not mention, shows that in preparations consisting of a portion of stem carrying one leaf only, similar to those on which the above experiment also was performed, excitation cannot be conducted basipetally by movements of water in the wood. For the killing of a zone of the petiole by a jet of steam was found absolutely to prevent all basipetal conduction, though acropetally excitation could still be conducted—no doubt by a stimulant moving up in the transpiration current (Expt. 13).

Prof. Dixon does not refer either to the remarkable and more numerous experiments, which I quoted, by Prof. Herbert,[3] who, with a skill much greater than I could provide, had previously interrupted, in various ways, the continuity of the various tissues of the petiole of *M. pudica,* and had concluded that the path of conduction is the phloem. It would be regrettable if proper notice were not to be taken of Prof. Herbert's work, just because he has published in a little-known journal.

Finally, with regard to high-speed conduction in

[1] Dixon, H. H., NATURE, vol. 136, p. 626, October 25, 1924.
[2] Snow, R., Proc. R.S., B, vol. 96, p. 349, 1924.
[3] Herbert, D. A., *The Philippine Agriculturist*, vol. 11, No. 5, 1922.

the stem, Prof. Dixon seeks to explain this as due to a "rupture of the tensile sap" in one or two vessels. In cases in which the cut that set up "high-speed" conduction was found to have reached to the cambium only, and not to the wood, he supposes that the sap in the vessels was ruptured by pressure from the razor upon adjacent cells: he quotes in support certain observations by Böde. Since the cuts were made obliquely and slowly with a sharp razor, there can only have been very slight pressure on the vessels. Further, on looking up Böde's work[4] (p. 101 *seq.*), it will be seen that he does indeed state that pressure from the flat side of a lancet-needle caused bubbles to appear in uninjured vessels of various plants, though strong pressure was needed except in wilting shoots. But he goes on expressly to point out (p. 103) that yet the columns of sap did *not* break. A film of water surrounded the bubbles, which were seen gradually to disappear.

Moreover, my experiments were made on cut shoots, cut under water and rested with their bases in water for at least 1½ hours. No doubt in the upper parts of these shoots there was considerable tension on the water columns owing to the resistance of the conducting channels below. But I find in my notes five cases in which the cuts that set up "high-speed" conduction were made in the basal internodal portion, less than 4 cm. long, below the lowest leaf, including one in which the cut was only 5 mm. from the extreme base, and another in which the cut reached only down to the cambium. In these basal stem portions it is hard to see how there can have been much tension on the water columns. In still another case (Expt. 7) "high-speed" conduction was set up by cutting off a short length from the base of a shoot totally submerged for 3 hours under water. It does not seem possible, therefore, to explain the "high-speed" conduction of the stem either by movements of water in the vessels.

In his letter of January 10, Sir J. C. Bose gives the impression that I have disagreed entirely with his views on conduction in Mimosa. Actually, however, in agreement with him I have produced evidence to show that in the leaf, excitation is conducted in the phloem and has nothing to do with the transpiration current. I agree also that this conduction in the leaf is, in all probability, a true physiological process, and consider that Sir J. C. Bose's experiments on the petiole, which so strongly support this view, are of very great value. In the stem, however, as I found, this conduction in the phloem either fails completely, or at least is regularly too weak to cause the leaves to fall. The result is that in the stem, Dr. Ricca's slower mechanism of conduction by the transpiration current is able to reveal itself. With regard to the "discontinuity" experiment on the stem, it is difficult to take seriously Sir J. C. Bose's suggestion that Dr. Ricca and I both committed the truly remarkable blunder of being misled by a direct effect of the stimulating flame upon the leaves above the water-filled tube. It is impossible that such an accident should have caused a perfectly normal conduction up the shoot, in which the next leaf above the tube did not fall until about 40 seconds after the leaf below the tube. I would refer him to Dr. Ricca's original experiments also, who kept his shoots horizontal. If Sir J. C. Bose has failed to repeat this experiment on the stem, this can only be because his experimental arrangement is unsatisfactory.

R. SNOW.

Magdalen College, Oxford.

[4] Böde, H. R., *Jahrb. f. wiss. Bot.*, vol. 62, 1923.

The Velocity of Oxidation of the Metals and the Structure of Coloured Oxide Films.

WHILE general opinion ascribes the appearance of temper colours to interference between the light reflected from the outer and inner surfaces of a coherent film of oxide, no very definite proof has hitherto been brought forward that this view is correct, and many opinions have been stated to the contrary. The observation of Mallock (Proc. Roy. Soc. 94A (1918), 566) that the colours are unaltered in hue and only diminished in intensity by grinding away the film, has appeared to many to be irreconcilable with the hypothesis that interference is the cause.

We have recently obtained evidence which we believe to render indisputable the claim for interference. In a series of papers published recently in the *Zeitschrift für Anorganische Chemie*, Tammann has described experiments in which he made use of the film colours (assuming interference as their cause) to measure the rates of "dry" oxidation of the metals. For many of the metals he found the velocity of oxidation to be proportional to t^{-1} (t being the time reckoned from the moment of first exposure to oxygen), the proportionality factor being dependent on the nature of the metal, its temperature, and on the partial pressure of the oxygen. In the course of a study of the oxidation of zinc, in which the rate of fixation of the oxygen was determined directly, it has been found in this laboratory that the rate of reaction is proportional to $t^{-(1-a)}$, where a is small as compared with unity. While these measurements are not therefore in complete agreement with those of Tammann, the close approximation of the two expressions would appear to constitute a quantitative proof that interference is the true explanation of the colours.

Ill-defined colour changes were occasionally noticed in the experiments on zinc described, but since it was necessary to sublime the metal *in vacuo* (to free it from occluded gases), no estimate could be made of its surface area. C. N. Hinshelwood, however, (Proc. Roy. Soc. 102A (1922), 318) gives data for the oxidation of copper from which it is possible to make a comparison of the amounts of fixed oxygen (which he determined directly) with the thicknesses of the films as estimated from their colours. Assuming the oxide formed to be cupric oxide, Hinshelwood gives the following data:

Gm. of CuO per sq. cm. of Copper Foil.	Colour of Film.
0·000030	Purple.
0·000043	Blue.
0·000073	Light Green.

If, as the interference theory would require, the oxide forms a coherent film which clings tightly to the metal, Tammann is almost certainly correct in supposing that the oxide primarily formed on copper is cuprous and not cupric oxide. For while in the space-lattice of the lower oxide the copper atoms are arranged precisely as in the metal itself, and at nearly the same distance apart (so that the passage from the metal to this oxide can take place with a minimum of disturbance) the higher oxide has a much more complex structure which could only be formed by the breaking up of the original lattice-pattern. Taking the density of cuprous oxide to be (roughly) 6 gm/c.c. and its refractive index as 2·7, the thicknesses of the air-films which should give colours corresponding to those shown by cuprous oxide films containing the above amounts of oxygen per sq. cm.

are calculated to be, respectively, 243, 348, and 590$\mu\mu$. Referring, for example, to the Landolt-Bornstein "Tabellen" for the colours characteristic of air-films of about these thicknesses, one finds the following:

257$\mu\mu$ Purpur $\begin{cases} 300\mu\mu \text{ Himmelblau} \\ 352 \text{ Heller Himmelblau} \end{cases}$ 600$\mu\mu$ Meergrün.

If interference were not the cause of the phenomenon, it would be a sufficiently curious coincidence that the thicknesses calculated should come *at all* within the range of those giving rise to Newton's colours.

Hinshelwood remarks that successive oxidations and reductions of a copper surface led to an intensification of the film colours produced, and to a correspondingly greater rate of fixation of the oxygen. He showed that the amounts of oxygen required to form films of the above colours remained in constant ratio. The simplest explanation of these facts would appear to be that the treatment causes a roughening of the surface, whereby the effective area of the metal is increased. If this should prove to be the case, it would provide a not unlikely explanation as to why the colour remains unaltered when the outermost surface is ground away.

D. H. BANGHAM.
J. STAFFORD.

Chemistry Department,
Manchester University,
December 12.

Stonehenge: The supposed Blue Stone Trilithon.

I HAVE read with much interest the review which appeared in the issue of NATURE for November 1, headed "Archæology of Stonehenge," not only as a thoughtful criticism on my recently published work, but also as a valuable up-to-date addition to the literature on the subject.

The matter of the supposed Blue Stone Trilithon is of some importance in regard to the design of Stonehenge. It has been commonly supposed that the two cup-shaped hollows now to be seen in Stone No. 150 may be mortise sockets, indicating that the stone had been the lintel of a miniature trilithon. In my book I have discussed the subject in some detail, and have given references to authorities and a photograph of the stone. The conclusion arrived at is that these cup-shaped hollows have nothing to do with the original design of Stonehenge, but may very likely have been mortars for grinding grain, formed, perhaps, by prehistoric squatters on the site long after the building of Stonehenge, when the structure was already in a partly ruinous condition.

In reference to this the writer of the review remarks:

> "The author is in error over a fallen foreign stone which figures in Plate 6, Fig. 2, in supposing the two holes seen on it were made, after it had fallen, . . . It is curved in the same way as are those of the outer circle, but in this one the curve is sharper, showing it belonged to something smaller. The holes in the stone are equidistant from the ends and are dowel holes like those in the big lintels, and this stone may formerly have fitted over the terminal upright stones of the horseshoe."

As a matter of fact, the centres of the hollows in the stone are *not* "equidistant from the ends." The one towards the north is 2 ft. 6 in. from that end of the stone and the other is 1 ft. 11 in. from the farther end. The distance centre to centre of the hollows is only 3 ft. 5 in., and if a drawing be made to scale showing two of the obelisk-shaped stones of the horseshoe at this distance apart (centres), with this supposed lintel on top, it will be seen that the two uprights would have to be not much more than a foot apart in the clear (instead of the normal clearance of four or five feet). The tail-end of the (supposed) lintel would moreover have a considerable unsymmetrical overhang beyond its upright. Such an abnormal arrangement is of course possible, but from what we know of the work of the builders of Stonehenge it may be regarded as most improbable.

An attempt to form a trilithon with this stone as lintel supported on two of the shapeless boulders of the blue stone circle would be found even more impracticable.

It is to be noted, moreover, that the face in which the hollows appear is not even, and the hollows are askew with each other (see Fig. 1). The stone has a considerable curvature which would unfit it for a place at the end of one of the straight limbs of the horseshoe. This curvature is double (slightly S-shaped), and is merely the form of the original boulder. It is not dressed, and has therefore no significance.

It will further be observed that among the blue stones remaining on the site there is no stone that has any sign of a tenon on its top, or which bears any indication that it may have been an upright for a trilithon—nor is there any other stone which has cup-shaped hollows like those on Stone No. 150. All the blue stones (now remaining) are, moreover, exceedingly hard (diabase and rhyolite) and show no sign of weathering.

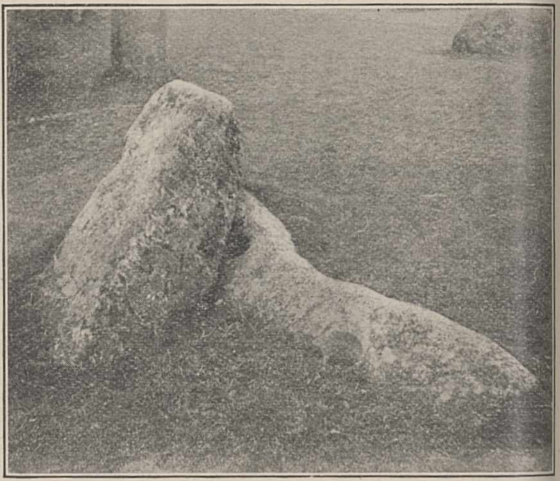

FIG. 1.

On the evidence of the physical facts noted above, and from other considerations set forth in my work on Stonehenge, it may be regarded as extremely improbable that Stone No. 150 could have been the lintel of a trilithon. It will, moreover, doubtless be agreed that if this stone had been dug up in the course of excavation on the site of a prehistoric village, the conclusion that the hollows were mortars for grinding grain would have been accepted as obvious.

Mr. Edward T. Stevens, the eminent Wiltshire archæologist, writing on this subject in 1876, remarks as follows:

> "The two cavities in the prostrate foreign stone are too far from the ends of this particular stone, and too close together, to justify one comparing it with the imposts of the outer circle or outer horseshoe. No trace remains of either of the syenitic uprights upon which it rested. This stone, however, is quite as likely to have served for an altar as for an impost, and the cavities may have been intended to receive libations or offerings of some kind."

Stevens then goes on to describe similar stones found in Sweden known as "elf-stones," which are still held in superstitious veneration and receive offerings to ward off sickness. He adds: "I venture to suggest, therefore, that some further attention be given to this subject, before we jump to the conclusion that this foreign block of stone was an impost." (Jottings on the Stonehenge Excursion, August 1876, pp. 133-138.)

E. HERBERT STONE.

The Retreat, Devizes.

The Word "Scientist" or its Substitute.

WHEN literary gents, like Sir Clifford Allbutt, Prof. D'Arcy Thompson and Sir Israel Gollancz, come forward in defence of *scientist* and Sir R. A. S. Paget, an expert in vocal sounds, in the most cold-blooded manner possible, says that he would *ist* everybody, it were time that we illiterate sciencers ranged ourselves solidly with Sir Ray Lankester, ever a defender of the faith, proclaiming that we will not have truck with the would-be debasers of lingual beauty.

If I had ever favoured the term—I hate it—I should cease from using it, if only after listening to the High Commissioner for Australia, at the Imperial College of Science (not yet Scientists) dinner, a few days ago. Replying for the guests, at the close of his speech, he referred to the story of two men talking together and one saying—"There will be nothing to laugh at fifty years hence." "What, will there be no scientists!" came the reply. Let us hope there will not be any. The story is a good exemplification of our form in the public eye.

The real men, those who do things—bakers, butchers, builders, boxers, grocers, even green-grocers —all have names ending in *er*. The terminal *ist* is reserved for theosophists, thaumaturgists, even for those who pretend to be but are not chemists, only bits of the same. So far, indeed, is objection taken to chemist that a wag among them has proposed to substitute *chemor*, not chemor-ist, be it noted. The German *chemiker* was long known as superior to the English *chemist*. Still, *er* has its weak side to some— I am told that, in New York, the undertaker seeks to be known as the moritician. The fact is, none of us likes his name.

The Oxford Dictionary, a mine of inspiration which is too little used, gives *Sciencer* and *Sciential*, both euphonious words. Of late, I have often used sciencer, and like it. Sciential has the authority of Keats and is less committal—it may even be applied not merely to the properly scientific but also to those who neither do nor make anything but merely talk and claim to be of the elect, though I should bar classical telepathists. As to Dr. Jeans, for whom solicitude is properly expressed, he may well be spoken of as a sciencer, if not reckoned with magicians: all will devoutly pray that he be kept away especially from *ists* in the guise of psychists.

I write this without consulting my sons but believe they would all support me, though I have not gifted any one of them with a musical ear—one of them, however, was brought up under Sir Clifford Allbutt in days when he was the boldest of warriors in defence of our English tongue.

We shall do well to take notice that scientist is fast becoming a word of evil import in the public ear—as meaning one of the set of peculiar people who talk a language no fellow can understand. Some day, soon, perhaps, the call may come to label NATURE: the Journal of Babel; the Dictionary will then give—Babel, the language of a sect devoted to an obscure practice known as science.

HENRY E. ARMSTRONG.

SCIENTISTS have hesitated to use the word "scientist," not because it is a hybrid (they are well used to hybrids); nor because it ends in a sibilant "-ist" (they are most of them "-ists," of one kind or another); nor because the word is appropriated by the unqualified (professors are inured to such treatment); nor yet because the word was originally used opprobriously (they are not really less courageous than Tories or Radicals); but because they were diffident. They feared to offend classical taste. No scientist ever puts his pen to paper without casting a fearful glance over his shoulder to see whether a classic should be looking on. You may reproach a classic with ignorance of science and he will plume himself with the compliment. But to suggest to a scientist that he is guilty of a classical lapse is more mortifying to him than to tell him he should have said "napkin" instead of "serviette." It is thus sheer nervousness which has prevented him from using a generic term as obvious and inevitable as is the word "artist." Now, thanks to you, the scientist is discovering, with something of the naïveté of M. Jourdain, that the classic never dreamt of objecting to the word and only wonders why there should be so much shyness about the use of it.

J. W. WILLIAMSON.

Gray's Inn, W.C.1.

Anomalous Dispersion in the Field of X-Rays.

IN the course of an investigation with the purpose of getting more exact determinations of the wave-lengths of the X-ray spectra, we have carried out a comparison of the lattice-constants of the two crystals, calcite and gypsum. In order to find the best possible value of this fundamental relation, we used a series of different spectral-lines with wave-lengths varying from 0·7 up to 5·2 Å.U. The measurements of the relation are given graphically in Fig. 1, where the values of $\frac{d_1}{d_2} = \frac{\sin \phi_2}{\sin \phi_1}$ are plotted against the wave-lengths. As seen from the graph there are two

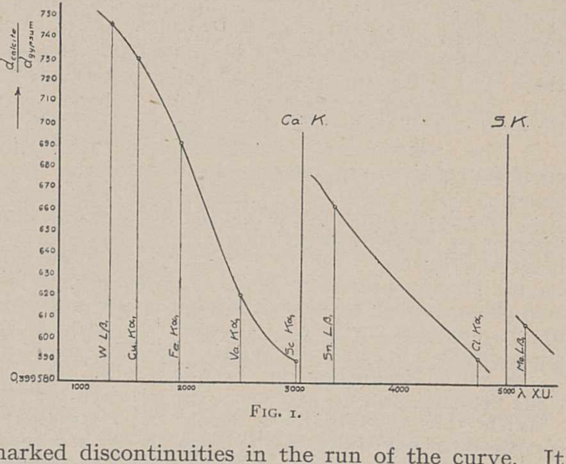

FIG. 1.

marked discontinuities in the run of the curve. It is also seen that these two abrupt variations coincide with the wave-lengths of the absorption-edges of calcium and sulphur.

It may be seen from the theory of X-ray reflection by crystals as given by Darwin and Ewald, that such an anomalous dispersion is to be expected. From these theories it is known that the simple Bragg law of reflection

$$n\lambda = 2d \sin \phi$$

is still valid if we give a modified meaning to the constant d, that is, if d means, not the true distance d_0 between the reflecting planes but a corrected value

$$d = d_0\left[1 - \frac{4d_0^2}{n^2}\frac{\delta}{\lambda^2}\right],$$

where δ has the value known from the ordinary dispersion-theory :

$$\delta = \frac{e^2}{2\pi c^2 m}\sum_{i=K,L,M\,..}\frac{N_i}{\nu^2 - \nu_i^2},$$

and ν_i are the natural frequencies of the K, L, M, etc. electrons.

On passing one of the natural frequencies, the value of d apparently undergoes an abrupt variation quite in accordance with the experimental results.

It may be noticed that the graph is not a simple dispersion-curve, as it gives the relation between *two* such curves, namely, that of gypsum to that of calcite. The discontinuity at calcium is due to the fact that the relative number of the K-electrons of this element per unit volume is different at the two crystals.

This result shows that it is necessary in all accurate measurements of X-ray wave-lengths to use a corrected Bragg formula for the calculation of the wave-lengths from the angles of reflections. For this purpose, the first condition is to know the dispersion formula of the crystal for X-rays. Such an investigation may be carried out with the ordinary prism-method applied for X-rays, as shown in a communication from this laboratory (*Die Naturwissenschaften*, December 26) or with the method given by Bergen Davis and his collaborators.

ELIS HJALMAR.
MANNE SIEGBAHN.

Fysiska Institutionen,
Upsala Universitet,
December 12.

Scattering and Absorption of γ-Rays.

IN a recent letter to NATURE (January 3, p. 13) I have stated that, on current theories, it is exceedingly difficult to account for the results of experiments on the scattering and absorption of hard γ-rays. I should like to add to this statement that a reasonable explanation of such results has since been obtained by means of the following assumptions, for which there is a certain amount of evidence :

1. The secondary β-rays produced in light elements by hard γ-rays are practically all recoil electrons.

2. The photoelectric or fluorescent absorption coefficient of γ-rays varies as the cube of the wave-length.

3. The hard γ-rays of radium-C behave in the same manner as would a mixture of two types of wave-lengths 0·024 and 0·008 Å.U. respectively, each type having about 50 per cent. of the total energy.

4. The number of quanta scattered per unit area at an angle θ varies as $(1+\cos^2\theta)/(1+2\alpha)$, where $\alpha = h\nu_0/mc^2 = 0{\cdot}0242/\lambda_0$, h being Planck's constant, ν_0 the initial frequency, m the mass of an electron, c the velocity of light, and λ_0 the initial wave-length.

With the angular distribution of "scattered" quanta proposed above, the average energy of a recoil electron, for values of $\alpha > 1$, approaches closely the maximum energy E_M which equals $2\alpha h\nu_0/(1+2\alpha)$. Further, as α increases, the total energy of the recoil electrons becomes a greater and greater proportion of the energy lost by the scattering process, *e.g.* when $\alpha = 3$, the total energy of the recoil electrons is equal to twice the energy of the scattered γ-radiation. These are the reasons why one can account for the observed energy of the secondary β-rays when it is assumed that a large proportion of the total γ-ray energy is of the softer type, it being necessary to assume that this type is present in order to account for the observed values of the fluorescent absorption coefficient.

It might be mentioned that, with distributions of scattered quanta hitherto proposed, the average energy of a recoil electron is about $\frac{1}{2}E_M$, and the total energy of the recoil electron is always less than that of the scattered γ-radiation.

I believe it can be shown, from what has been proposed above, that γ-rays must have a "range"; *i.e.* for rays of any one wave-length, there could be a certain thickness of material, through which the rays would not pass, no matter how great the initial intensity. This would indicate that the scattering of γ-rays is a scattering of "corpuscles," a view which I referred to and rejected in a former paper (*Phil. Mag.*, p. 611, 1913).

In my letter of January 3, p. 13, it is stated that, "Taking the average energy of such a β-ray to correspond to 467,000 volts, . . . a simple calculation shows that only one in every five radium-D atoms emits a γ-ray on disintegration." The figures should have been 333,000 volts and only one in every seven radium-D atoms emits a γ-ray on disintegration.

J. A. GRAY.

Queen's University,
Kingston, Ontario.

Spermatogenesis of *Succinea ovalis*, Say.

AN investigation of the spermatogenesis of *Succinea ovalis*, Say., a small terrestrial pulmonate of North America, has revealed the following :

1. Forty chromosomes are found in the spermatogonial divisions, and twenty in the maturation divisions.

2. Typically of all pulmonates so far studied, there are two centrioles, proximal and distal. Early in spermogenesis the proximal centriole penetrates through the nucleus of the spermatid, and with the surrounding intranuclear canal, forms an intranuclear rod in very much the same way as has been reported for certain prosobranchs.

3. Both the head and tail of the spermatozoon have a spiral twist. These spirals go in either a clock-wise or counter clock-wise direction, one type being about as common as the other.

Of the cytoplasmic structures, the mitochondria and the Golgi apparatus were followed through all stages of spermatogenesis.

The mitochondria are seen in the early primary spermatogonia as small masses of granules lying near the nuclei. They increase in size and number in the primary spermatocytes, and at each of the maturation divisions they are distributed approximately equally between the daughter cells. Some of the granules go to form the sheath of the axial filament of the spermatozoon, while the rest are sloughed off with the cytoplasmic balls.

The Golgi rods cannot be identified with certainty in the primary spermatogonia. In the primary spermatocytes they occur as conspicuous banana-shaped rods grouped closely around the idiosome; 15-20 rods can be counted in these stages. During dictyokinesis there is no fragmentation of individual rods, but they are distributed intact to the daughter cells. 3-5 rods are found in the spermatids. In the final ripening of the spermatozoon, the apparatus is seen in the cytoplasmic balls as faintly-staining, disintegrating bodies.

A more detailed account will be published later.

CLEVELAND P. HICKMAN.

Department of Biology,
Princeton University, U.S.A.,
November 26.

Biographical Byways.[1]

By Sir ARTHUR SCHUSTER, F.R.S.

3. BALFOUR STEWART (1828–1887).

IF I were asked to name Balfour Stewart's outstanding quality as a scientific investigator, I should designate his absolute freedom from preconceived ideas both in the selection of his subjects and the manner in which he treated them. He was fond of arguing by analogy or familiar illustration. According to the writer of his obituary notice in the Proceedings of the Royal Society, who knew him intimately, he was "full of the most weird and grotesque ideas." I cannot say that I ever became conscious of this in my own intercourse with him, but I only came into contact with him after his slow recovery from the injuries sustained in the Harrow railway accident of 1870. He was not a good lecturer and had difficulty in keeping order in the lecture-room—perhaps it would be more correct to say that he did not take the trouble to keep order, being too sympathetic with youthful exuberance. In the laboratory he was an inspiring teacher, and it would not be an exaggeration to say that he was the godfather of much of our modern science, both Poynting and J. J. Thomson having received their first lessons in physics from him.

Balfour Stewart's family intended him for a mercantile profession, and at the conclusion of his university studies he spent some time in Australia. But science had laid its spell on him, and he soon returned to Edinburgh, where he became assistant to J. D. Forbes, who had considerable influence in shaping his mental outlook. It was during the six years he spent at Edinburgh that the work on the equilibrium of temperature radiation was begun and, in its essential features, completed. In 1859, Balfour Stewart was appointed superintendent of the Kew Observatory, which was then managed by a committee of the British Association under the presidency of P. Gassiot. All went well until the organisation of the meteorological service of the country was transferred from the Board of Trade to a committee of the Royal Society, consisting of eight Fellows, with General Sabine as chairman. The expenses were covered by a Treasury grant of 10,000*l*.

Trouble soon arose, and, I think, both for their historical interest and in justice to Balfour Stewart's memory, an account of the incidents which ultimately led to his retirement from the directorship of Kew Observatory should be given. I am enabled to do so on the evidence of the relevant documents, which came into my keeping after Balfour Stewart's death. When the Board of Trade had agreed to the request of the Meteorological Committee for the assistance of a scientific secretary, Balfour Stewart was appointed to that office, understanding that he was to be the scientific adviser of the Committee; but when afterwards he was designated simply as "Secretary to the Committee" he disliked the omission of the qualifying word "scientific," but acquiesced. "Nevertheless," he declared in a printed statement from which I quote, "I continued to understand that it was my special duty, in case I might see anything defective in the scientific position of the Committee, to urge them to amend it."

[1] Continued from p. 57.

Differences of opinion soon arose between Sabine and Stewart with regard to the method of reducing meteorological observations, and his repeated requests for clerical assistance were declined by the Committee. The crisis came when Balfour Stewart directed General Sabine's attention to what he considered to be an error in an unconfirmed minute of one of the meetings of the Meteorological Committee. Stewart's account of the interview which took place concludes with the following statement: "He [General Sabine] assured me there was no mistake and added in answer to a question that he, *on his own responsibility*, had authorised the preparation of such of those results at the central office as had not been authorised by the Committee." To use a familiar term, Sabine admitted having cooked the minutes. At the same time, Balfour Stewart was privately told that the chairman was much opposed to his scheme of reducing observations, and that there was not much chance of its being adopted. With regard to the merits of the proposed scheme there can be little doubt. Stewart had submitted it to a few independent men of science and the reply of the Astronomer-Royal, Sir George Airy, may be given *in extenso*.

> "I have read with much satisfaction the paper of your Remarks on Meteorological Reductions, etc., especially with reference to Vapour. I do hope that by going on thus you may make Meteorology a science of causation, and raise it from its present contemptible state.
>
> "I have often thought that much may be gained by ascertaining at what rate aqueous vapour disseminates itself through air, and should long ago have made experiments, but that I want a hygrometer of sufficient delicacy. I then thought of suggesting it to the Kew Committee. Your paper restores the interest in my old intention, and I think I shall write to Mr. Gassiot."

Lord Kelvin (then Sir William Thomson) also gave his full approval, writing:

> "I believe the plan you propose is adapted to bring out information of the most valuable kind, from observations which, until reduced on some such plan, might be accumulated indefinitely without any practical benefit."

Stewart was naturally distressed by the manner in which his advice was set aside, no scientific grounds being given. Fearing that the anxieties of his office might affect his health, he wrote a letter to the chairman of the Committee resigning the secretaryship. He also tendered to Mr. Gassiot his resignation as superintendent of Kew on the ground that the two bodies were closely bound together, but declared at a meeting of the Meteorological Committee that he gave up this office with extreme reluctance. He was asked, in an interview with Mr. Gassiot, whether there was anything that would induce him to withdraw his resignation, and was given to understand that Sabine would wait to hear the condition under which he would continue office before taking further steps. Stewart then wrote a letter explaining the difficulties in which he was placed owing to insufficient help in the numerical work and stating that, if some assistance were given him in the preparation of the preliminary reductions of the observations, he desired to withdraw his letters of resignation. The reply was as follows :

"I regret that you were so determined to send in your resignation. It appears Sir Edward Sabine has written to Bombay, where Colonel Smythe is, and nothing can be done until the reply comes."

Sabine's letter referred to, offering the appointment to another man, was posted on the day of the interview with Gassiot, and—as Stewart points out—before his resignation had been formally accepted by the respective committees.

The obstinacy with which Sabine pressed his own opinion is perhaps intelligible in a man who was then eighty-one years old, but there is nothing to say in extenuation of the want of generosity exhibited in the following letter to Stewart :

"My not having responded to your request more promptly and more fully, has not arisen from want of solicitous thought, and wish to serve you.

"I feel assured that if your work at Kew had ere now been crowned by the looked-for completion of the account of the results of the long and invaluable series of magnetic observations, the later and longer portion of which were under your own superintendence, you might, and I might, have appealed triumphantly to such an evidence, not only of what you were capable of doing, but of what you had done, as placing you in a pre-eminent position."

The letter is dated May 31, 1870, and was presumably written in answer to a request for a testimonial in view of Stewart's candidature for the chair of physics at Owens College, Manchester. With regard to the implied complaint, I have before me the copy of a letter written by Balfour Stewart, from which it appears that he was waiting, previous to 1865, for the details of the observations which were in Sabine's possession. In spite of his repeated requests they were never sent to him. He could scarcely be expected to start on an extensive work of reductions before he had the whole material before him.

Balfour Stewart's greatest scientific success was achieved in his researches on the equilibrium of radiation in an enclosure of uniform temperature, which led to the enunciation of the connexion between radiation and absorption. His omission to drive home convincingly the application of his results to the explanation of the dark Fraunhofer lines was, in his own later opinion, due to a want of chemical knowledge. Looking at a flame coloured with common salt, and believing that the yellow colour of the flame was due to luminous sodium chloride, he was disappointed to find that a plate of rock salt did not sensibly absorb the emitted light.

Stewart had the faculty of recognising the importance of problems, even when he had not the power theoretically or experimentally to make much headway in their solution. He saw, for example, the need of studying the temperature equilibrium in an enclosure which contained moving bodies, both radiation and absorption being affected by the Doppler effect. But instead of looking for the solution of the difficulty—as was subsequently done by Wien—in an adjustment of the law of radiation as depending on temperature and wave-lengths, he imagined that the equilibrium of radiation was actually destroyed, the second law of thermodynamics being satisfied by the mechanical forces necessary to maintain the motion. In conjunction with Tait he designed an experiment in which a disc was kept rotating *in vacuo*, and believed he had actually discovered an increase of the temperature of the disc. The success of the experiment depended of course on the perfection of his vacuum, and Stewart shared the erroneous belief of the time that a perfect so-called chemical vacuum could be obtained by filling a vessel with carbonic acid, exhausting with an ordinary air pump and absorbing the remnant of the gas with caustic potash.

I have remarked that Stewart's mind worked a good deal by analogies. He was fond of one particular illustration. Imagining a moving train and a body of men cutting across by jumping into it from one side and out of it at the other, it is clear that the train will gradually lose speed. The idea was applied to special cases and suggested several experiments to him. I joined him in one of these, in which an electric current was passed through water and an electromotive force applied at right angles to the current. Stewart hoped to detect some interference of the currents with each other. The same type of reasoning was in his mind in contemplating possible mechanical effects of radiation. I believe that at the bottom of these speculations was some prophetic glimmering that a propagation of energy always implies a propagation of momentum. The weak feature of his work was, that he often designed and tried experiments of a refined nature with appliances which were insufficient, and even at that time might have been improved upon—such were his attempts to discover a screening effect of metals on gravitation, or a change of mass by chemical combination. In the latter experiments, in which the combining bodies were mercury and iodine sealed up in a glass bottle, J. J. Thomson, who assisted him, nearly lost his eyesight through an explosion.

Stewart was indefatigable in his work. While the days were spent in the laboratory, he pursued his statistical investigations on magnetic and solar phenomena in the evenings. Some of these researches are published under the joint names of himself, De la Rue and Loewy. The latter gentleman—though I believe he had some claim to scientific knowledge—was chiefly employed as an assistant, paid for carrying on the numerical work, which was often heavy. I believe that De la Rue's share consisted in supplying the funds. One morning Stewart arrived at the laboratory in a great state of distress. In looking over the proofs of a paper accepted for the Philosophical Transactions, he had found that the numerical work was all wrong. Loewy had, in fact, saved himself trouble, and evolved the results out of his inner consciousness. The paper had to be withdrawn, and De la Rue paid a substantial sum for the expenses already incurred in printing. Neumayer, who was at the time director of the "Sternwarte" at Hamburg and on whose recommendation Loewy had been engaged, told me afterwards that he had sent for Loewy and charged him with manipulating the results. Loewy admitted doing this, but excused himself on the ground that, while he had originally worked honestly, Stewart had never checked his results, so that the blame must be his.

Some reference should be made to a little volume, "The Unseen Universe," published in 1875, and intended to reconcile science with revealed religion. It appeared anonymously at first and, though probably forgotten now, it created a sensation at the time, running rapidly through many editions, in the later ones of which the authors' names—Balfour Stewart and P. G. Tait—were given. Referring to Tait's contribution, Stewart told me that when he first approached him, suggesting a joint publication, his consent was subject to the condition that Stewart should write the book while he would make himself responsible for the preface. When this was agreed to and the manuscript of the preface arrived, Stewart was amused to find that it was almost entirely taken up with an attack on John Tyndall, who was Tait's *bête noire*. It had to be re-written, and to judge from internal evidence I should surmise that not much more than the first paragraph was Tait's work. I am under the impression, nevertheless, that Tait's share in the book was not negligible, and that though he acted mainly in an advisory capacity at first, he made substantial additions in the later editions.

Towards the close of his life Stewart became much interested in so-called spiritualistic phenomena, but he always insisted—sometimes with great vigour—on his disbelief in messages from the dead, which were contrary to his religious convictions. With regard to unexplained phenomena, in which fraud may possibly have a share, it must be said that Stewart's confiding nature rendered him quite unfit to act as a judge. He was like a child in these matters. A certain personage near Buxton—so far as my recollection goes, a clergyman—wrote to Stewart about his powers of second sight, which enabled him to find a hidden object or name a card drawn at random out of a pack. Stewart went to see him several times and was impressed. "What is most remarkable," he told me after the second or third visit, "is that the power can be transferred to others. There is a servant girl in the house who, after a stay of a few weeks, has acquired it and can now name an unseen card just as well as her master." Not a shadow of suspicion had crossed his mind.

Stewart's conversation was always suggestive and sometimes witty. The Principal of Owens College had a habit of writing letters to the professors when he had any fault to find. These always began with some complimentary remarks, the sting being reserved for the concluding sentence, or frequently a postscript. "Every billet has its bullet" was Stewart's comment after receiving one of these communications.

The Theory of Evolution since Darwin.[1]

By Prof. E. W. MACBRIDE, F.R.S.

THE most recent development of the doctrine of evolution is the revival of Lamarckism—that is, the belief in the inheritable nature of the effects of use and disuse. Just as Bateson in 1894 enunciated the doctrine of the origin of species by sports long before this view was consecrated by the experimental labours of De Vries and given the name of the "mutation theory," so Eimer (1887) and Cope (1888) rebelled against the Weismannian conception of an unalterable germ plasm totally independent of the effects of the experiences of the body. Eimer put forward the doctrine of orthogenesis. This theory states that variations are the results of the effects of the environment on the complex constitution of the living organism, but that this constitution determines the character of these variations; they are not indefinite, but take place in a few definite directions. Eimer, who chose for his special subject of observation the wall-lizard *Lacerta muralis*, and later the swallow-tailed butterflies, pointed out that new variations make their first appearance in the later stages of growth and become inherited earlier in life as the generations succeed one another. A beautiful example, he explains, is afforded by the Ammonites, in which new features are first distinguishable in the outer coil of the shell, which is, of course, the youngest and latest to appear, whereas in succeeding strata the new feature is found affecting the more central coils. Thus it will be observed that Eimer draws the most decisive support for his theory from palæontology. Eimer seems to suppose that he is an opponent of Lamarck, but the only difference between them that I can discover is that Eimer seems to regard external conditions as altering the hereditary tendencies by direct action as sulphuric acid acts on metal, whereas Lamarck considers that external conditions stimulate an organism to make a response, and that it is this tendency to response that is inherited.

Cope, in his book "The Origin of the Fittest," likewise advocates the inheritance of the effects of use and disuse, and relies on palæontological evidence to support his view. He points out that if the development of the Ungulates during the Tertiary period followed, we find evidence that the shocks and strains to which the leg bones were subjected, and which in moderation create enlargement and strengthening of those bones during the lifetime of the individual, gave rise, as generation succeeded to generation, to permanent thickenings, fusions, and elongations of these bones; and that the modifications in teeth can likewise be explained as reactions to the changing character of the food by which the Ungulata were supported. Cope's views have become increasingly prevalent amongst North American palæontologists, and are almost universally accepted by them to-day.

The first great blow to Weismannism was delivered by the cytologists and experimental embryologists. The foundation stone of the "germ-plasm" theory was the fundamental distinction between body cells and germ cells, and the theory that, as development proceeded, the body cells were specialised so that each could only give rise to its special part of the body. But Driesch showed (1900) that if certain segmenting eggs were fragmented, a piece so small as one-eighth of the whole could give rise to a complete embryo, and Hertwig and Driesch further proved that the arrangement of these cells could

[1] Continued from p. 55.

be entirely altered by pressure, so that cells which normally gave rise to the front or back were displaced to the sides, and yet that perfectly typical embryos were formed. More exact methods of investigation showed that the structure of all the nuclei in the body was alike, so that each cell might be regarded as a potential germ cell, and that the differentiation of the organs of the body was not accompanied by a differentiation of the nuclei but was due to local changes in the protoplasm. Therefore the same kind of nucleus—if the nucleus was to be regarded as the fount and director of life in the cell—must respond differently to different stimuli in different parts of the body.

Previous supporters of Lamarckism had assumed the necessity of the inheritability of the effects of use and disuse in order to account for changes which could be shown to have occurred, but it was not until 1908 that definite experimental evidence was adduced to show that changes artificially induced had, as a matter of fact, been transmitted to posterity. If this evidence were accepted, it was clear that the whole status of the questions must undergo a profound change, for a *vera causa* for the production of functional variations—in a word, of adaptations—would have been discovered. We have seen that strong evidence has been brought forward to show that minute differences distinguishing brothers and sisters of the same family were not inheritable, while "mutations" or "sports" were strongly inherited. These sports are, however, invariably pathological or monstrous in character, and if they occurred in Nature would have no chance of surviving or propagating their like.

The evidence in favour of Lamarckism was based on experiments with salamanders and toads which were carried out in Vienna. There exist two kinds of salamander in Europe, and one of them gives rise to only two young which at birth resemble their mother. The gilled fish-like larval stage with which the typical amphibian begins its free existence is in this salamander passed over within the womb of the mother. The colour of the skin is black and the animal lives on the cool Alpine uplands—it is named *Salamandra atra.* The other species of salamander is marked with bright yellow spots on a black background; it is an inhabitant of the lowlands and it gives birth to a considerable number (about thirty) of gilled young, which live for six months in the water before the gills drop off and the animals come on land. This species is named *Salamandra maculosa.* Now Dr. Kammerer, the investigator who performed these experiments, showed that if *Salamandra atra* was gradually accustomed to living in warmer and moister conditions, as reproductive period succeeded to reproductive period, it produced more young at an increasingly earlier period of development, and that when these young were reared to maturity and allowed to pair, the second generation gave rise to about half-a-dozen gilled young which took to the water and acted like the larvæ of *Salamandra maculosa.* Conversely, if *Salamandra maculosa* were made to live in comparatively cool and dry conditions, it began to carry its young for longer periods in the womb; fewer were produced at a birth, but these were born at a more advanced state of development. Finally, when these were reared to maturity and allowed to pair, the second generation gave rise to only two or three at a birth, and these were provided only with vestigial stumps of gills, so that they at once took up a terrestrial life.

If, again, the young of *Salamandra maculosa* just after metamorphosis were reared in cages the walls of which were painted yellow and black respectively, in those confined in yellow cages the yellow spots extended in area as the animal grew to maturity, so that after four years they were arranged in two conspicuous rows along the back. If two such animals were allowed to mate and produce offspring, when the resulting generation grew to maturity under the same conditions as did their parents, the yellow extended to such an extent as almost to suppress the black pigment. Those salamanders, on the contrary, which were reared in the black cages contracted the area of their yellow spots as they grew up; and when the second generation were reared under similar conditions, the animals became almost, if not quite, as black as *Salamandra atra.* The full effect, therefore, required two generations exposed to the same conditions to show itself, and the second generation started, so to speak, where the parents left off. If the offspring of salamanders which had been reared on a yellow background were reared on a black background, the yellow spots increased in area during the first six months of the animal's life; only after this period did the black begin to gain the predominance; in a word, the animal during the first period of its life *recapitulated* the history of the previous generation. This experiment constitutes, so far as I can determine, the first experimental proof of the biogenetic law which has ever been made. When the offspring of salamanders which had been reared on a black background grew up on a yellow background a unique effect was produced: the animals developed a single median stripe of yellow on the back. This is a form which is practically never found in Nature and can only be produced by experiment.

If we now turn to the experiments on toads, we may observe that nearly all toads, like the frogs, pair in water in the spring-time. The male embraces the female with his forearms and keeps her firmly in his grasp for a considerable period—often for weeks—until she emits her spawn, which he then fertilises. In order to enable him to retain a firm hold of his partner's slippery body, he has developed under the index finger a horny pad covered with minute asperities, the so-called nuptial pad. Now Alytes differs from all other toads in that pairing takes place on land, and as the female's body is comparatively dry and thorny the male does not require a nuptial pad in order to enable him to retain a hold on her. The eggs are fewer and larger in size than are the eggs of other toads; but as in other species, they are emitted in a string connected together by a cord of jelly. The male winds these cords round his legs and remains encumbered with them until the young tadpoles hatch out, a curious habit which has earned for him the name of "midwife toad." The tadpoles of ordinary toads emerge from the egg provided with three feathery gills on each side; as they grow these gills become covered over with a fold of skin proceeding from the head, and the larvæ assume the familiar form of a rounded body and flattened tail characteristic of the tadpole. The tadpoles of Alytes, however, pass through the stage with external gills whilst still within the egg-shell and emerge only when the body has become, as in the later toad-tadpole, rounded and plump. Whilst in the egg-shell they have only *one* external gill on each side.

Now Kammerer showed that although Alytes normally lived in cool spots, it could be induced to live at a warm temperature if it were provided with a basin of water in which to lave itself. In these circumstances, however, the male and female paired in water, and the eggs slipped off the legs of the male and lay in the water. By taking special precautions to keep the water aseptic, some of these were hatched and the resulting tadpoles reared to maturity. The next generation reared under similar conditions produced more numerous eggs which were smaller than those of the normal Alytes. Out of these eggs the tadpoles hatched in the external gill stage with one external gill on each side. In the next generation reared under similar conditions the tadpoles were provided with three external gills on each side as in ordinary toads, and in this generation the males developed horny pads.

These experiments aroused a quite different kind of criticism from that which had been evoked by any previous work, and one which strongly recalled the "odium theologicum" with which the first presentation of Darwin's theory of evolution was received in 1859. The experiments were admitted to be conclusive if true, but some critics declined to accept them. Kammerer visited England less than two years ago, bringing with him critical specimens, amongst them salamanders with a median stripe of yellow and a male Alytes showing the horny pad. Even then the critics were not convinced. It was asserted that the pad in the normal frog or toad was on the upper side of the hand and not on the lower side, and that therefore the specimen produced had not a true horny pad. In answer to this Kammerer asserted that in his Alytes—as his critics would have seen if they had examined it carefully—the nuptial pad was developed on the dorsal surface of the fingers but extended also round to their palmar surfaces; and to this answer I can add that the first four male frogs which I examined after this discussion all showed the pad on the lower surface of the hand as well as on the upper. But Kammerer showed other specimens on the same occasion which reduced all the discussion on the subject of the pad of Alytes to the level of "straining at a gnat and swallowing a camel." For all critics and supporters of Lamarckism alike admit that Alytes is descended from ancestors which, like more normal toads, possessed pads, and that the appearance of a pad in Alytes is therefore an atavism.

The most wonderful experiment, however, which Kammerer has ever published was that in which, *in one generation*, he had induced the blind cave-newt Proteus to develop a fully-formed eye. These creatures he brought with him to England, and there was no possibility of mistake about the matter. Proteus cannot be confounded with anything else; its pale flesh colour and reduced limbs are characteristic, and newts of this kind with large well-formed eyes were shown at the discussion. One is inclined to ask whether it is easier to produce a fully-formed eye than a mere cornification of the skin.

Kammerer's results have in the meantime been confirmed by the independent work of Durkhen on the colour of the pupæ of white butterflies. This work was carried out in the University of Breslau, and was published in 1923. The pupæ of this species normally have an opaque skin of a greyish-white colour, but in a small percentage (about 4 per cent.) this colour is absent and the skin is transparent, and so the pupa appears green, owing to the green blood shining through. If, however, the caterpillars are exposed to orange light, the formation of the white pigment of the pupa is largely inhibited, and the proportion of green pupæ rises to 65 per cent. If these pupæ are allowed to develop into adults and produce offspring and the caterpillars of the second generation are exposed to the same conditions, then the proportion of green pupæ rises to 95 per cent.; if the caterpillars of this generation are, however, left in ordinary daylight, the proportion of green pupæ diminishes, but is still 34 per cent. as compared with 4 per cent. in the controls. Here, as in Kammerer's experiments, we see that the reaction to the environment on the part of the first generation affects the second generation, and that a trace of it persists even when the second generation is replaced in the original conditions.

In England, Dr. Heslop Harrison, of the University of Durham, has observed that a certain melanic variety of moth is found where the food plants are infected with manganese salts derived from the smoke of adjacent factories. He fed the pale variety of this moth on food impregnated with the salts of manganese, and after several generations succeeded in obtaining melanic specimens, and from these he obtained a melanic progeny which bred true.

We are, therefore, in a position to state that after the lapse of the first quarter of the twentieth century, the doctrine of Lamarck has been submitted to the crucial test of experiment and proved to be true. Now evidence of the actual course of evolution is derived from three classes of facts, namely, those of systematic zoology (*i.e.* the mutual relations of varieties and species), those derived from a study of embryology, and, finally, those deduced from palæontology or the study of fossils; and systematists, palæontologists, and embryologists alike have been forced to the conclusion that the effects of habits must be inherited in order to account for the facts which they find in Nature. We are therefore justified in saying that habit, which is the reaction of the animal to its environment, has been the great factor in evolution, and that the splitting of the original stock into divergent species has been due to different members of the same stock under the stress of different environments adopting different habits. Prof. McDougall in "Psychology" has shown that this readiness to adopt new habits is a universal characteristic of living beings. "An animal when its activity is roused by a stimulus," writes McDougall, "pursues an end, and its activity continues till that end is attained or until it is exhausted. If it fails to attain that end in one way, *it will endeavour to gain it in another* until it achieves success." In this sentence, we venture to think, is contained the key to the riddle of evolution.

We might leave the subject here, but considering the vogue that the mutation theory of evolution has had, it is proper to consider whether any definite cause for these mutations can be found, and if so, what relation this cause bears to the reactions which set up habits.

Nothing has been more remarkable than the consensus of opinion of the upholders of the mutation theory that mutations are due to "chance," and yet, as Huxley remarked, one had hoped that a belief in chance had been finally exploded. Quite recently, however, a physiological cause for mutations has been suggested by Tornier, and much evidence in favour of it has been collected by him. The special subject of his investigations was the goldfish. The most bizarre races of this creature have appeared, and these races when crossed produce offspring which obey the Mendelian rules. Now Tornier showed that the races of goldfish had been derived from a small species of carp which inhabits the rivers of China. He found that the Chinese breeders kept their stock in small dark jars under insanitary conditions in which they were scantily supplied with oxygen. Much of the spawn died, and among the survivors all sorts of abnormalities turned up; from these the most striking specimens were selected and used to found the new breeds. These facts suggested to Tornier the view that the cause of the mutations was the weakening of the developmental energy of the germ by the abstraction of oxygen during an early and critical period of development.

Tornier showed that this weakening had two consequences: (1) it made the embryo sluggish in its movements; and (2) it diminished its power of regulation of the various processes on the harmonious co-operation of which the upbuilding of the body depends. Thus enormous fins were produced by the swelling of the yolk in consequence of undue absorption of water underneath the skin-area from which the fin developed, telescopic protruding eyes by the engorgement of the growing eyeball with water, and so on. By treating the eggs of newts and toads in such a way as partly to suffocate them for a short period after fertilisation, similar embryos were produced. Independently of Tornier, Jansen had arrived at a similar explanation of the cause of human deformities, the part played by the pressure of the swollen yolk in the goldfish's egg being assumed in the human embryo by the pressure of a too closely adherent amnion. What is inherited is, according to Tornier, not a factor or gene for an enlarged fin or protruding eye, etc., *but a certain grade of germ-weakness which in each succeeding generation produces the same morphological effects*.

If this view is correct—and all the evidence available conspires to show that it is—then mutations can have played no part whatever in evolution. Since they are the outward and visible signs of a weakened constitution, they are in a state of Nature ruthlessly weeded out by natural selection. Nevertheless they, like functional adaptations, are the result of the action of the environment—only in their case the animal has *failed to respond* to the changed conditions, whereas evolution depends on cases where the animal *has successfully responded*. In the last resort, therefore, like Darwin we come back to natural selection, only what is "selected" is not a chance variation or peculiarity but the constitutionally vigorous individual with ability of self-adaptation; what is rejected is the individual of weakened constitution.

Obituary.

SIR WILLIAM E. GARSTIN, G.C.M.G., G.B.E.

SIR WILLIAM GARSTIN, whose death at the age of seventy-five occurred on January 8, commenced his career in India in 1872 as an officer of the Public Works Department, after studying engineering at King's College, London. Thirteen years later he was invited by Sir Colin Scott Moncrieff, who had just taken charge of the Public Works Ministry in Egypt, to make one of the small group of Indian engineers who were undertaking the reorganisation of the irrigation system of Egypt, which was at that time in complete disorder.

In charge of the Circle of Irrigation which included the eastern half of the Nile Delta, Garstin spent seven arduous years in effecting his share of the restoration of the irrigation system, and then, on the retirement of Col. Justin Ross in 1892, he was appointed Inspector-General of Irrigation for the whole country. A few months later, on the retirement of Sir Colin Scott Moncrieff, he became Under-Secretary of State in the Ministry of Public Works.

At that time the irrigation system was being rapidly improved; the basin irrigation of Upper Egypt had been largely remodelled by Col. Ross, improvements in the Delta had led to large increases of crops, and larger supplies of water in the early summer were urgently required. Plans for a reservoir in or near the Nile Valley were being studied, and it fell to Sir William Garstin to advise on the scheme to be adopted. As a result, the Aswan Dam with subsidiary barrages at Assiut and Zifta were built, and by these means, and later developments of them, Egypt's low-stage water supply was assured.

As soon as Omdurman had fallen and the Sudan had been retaken, Garstin took prompt measures for the clearing of the Bahr el Jebel and the Bahr el Ghazel from the "sudd"—those blocks of drift and growing vegetation which had closed many of the channels. Sir William visited the Sudan on numerous occasions, and especially in 1901, and again in 1903, when he traversed Uganda also to see the headwaters of the Nile system. The investigations and surveys which were then initiated have since furnished a mass of hydrographical information of the highest value both to Egypt and to the Sudan.

Although his work in relation to irrigation is the most known in Great Britain, Garstin's position as the senior officer of the Ministry of Public Works in Egypt brought him in contact with many other forms of the public service. On his recommendation a geological reconnaissance of Egyptian territory was started in 1896, which soon developed into the present Geological Survey. The Survey of Egypt commenced in the Ministry of Public Works while he was in charge, and he warmly supported the various scientific activities which grew up in connexion with it.

The Department of Antiquities has always formed a part of the same Ministry, and in its work and its responsibilities Garstin always took a keen interest. As soon as the Aswan Dam was decided upon, entailing the partial submergence of the island and temples of Philæ, he took measures for the complete underpinning of all parts of the buildings which were not founded on rock; and later, when the raising of the Dam became necessary, he obtained the allocation of a considerable sum for the execution of an archæological survey of that portion of the Nile Valley which would be submerged. The present Museum at Cairo is also due to his efforts to house safely the ever-increasing collections of Egypt's ancient civilisation.

A keen sportsman, the wild fauna of the Sudan strongly attracted Sir William Garstin; from its inception he strongly supported and took an active interest in the Zoological Gardens at Giza.

H. G. L.

WE are indebted to *Science* of November 28 for the following details of the life and work of Prof. W. A. Locy, professor of zoology in Northwestern University, Illinois, who died on October 9 at the age of sixty-seven. William Albert Locy was born at Troy, Michigan, of Dutch ancestry, and received his early training in the University of Michigan. During the year 1884–85 he held a fellowship at Harvard, where he completed an embryological investigation on "The Development of *Agelena nævia*." In 1887 he went as professor of biology to Lake Forest University, where he remained nine years. During this period he published important papers on the embryonic development of the elasmobranchs, the derivation of the pineal eye, and the structure and development of the vertebrate head. In 1896 Locy succeeded Prof. E. G. Conklin at Northwestern University, where he remained until his death. His work there had two aspects; one, the developmental history of the sense organs, to some extent a continuation of his earlier researches; the other, the history of biological science. In 1908 he published a collection of historical portraits entitled "Biology and its Makers," which has since been translated into German, while in 1918 he produced "Main Currents in Zoology," and at the time of his death he was completing another work, "The Rise of Biology." The significance of his work on the history of science was recognised by his election as the first president of the History of Science Section of the American Association. He was also president in 1915 of the American Society of Zoologists.

WE regret to record the death, at the age of sixty-seven, of Prof. J. Bergonié, professor at the clinic for medical electricity and biological physics in the University of Bordeaux. Prof. Bergonié was chiefly known for his work on electro-therapy. He was the author of numerous papers, and was for many years editor of the *Archives d'Électricité médicale*, in which journal most of his original publications appeared. Among the most important of his original contributions to medicine we may mention "Contributions à l'étude du phénomène physique du muscle" and "Physique du physiologiste et de l'étudiant en médecine" (1892). Prof. Bergonié invented an ingenious device for localising metallic foreign bodies in the human subject, which was used to some extent in the War. He also invented an apparatus designed to treat the condition of obesity. He died as a result of injuries associated with X-rays and radium. During the last few years he had been actively at work upon the anti-cancer centre at the Hôpital St. André, Bordeaux. He twice received the gold medal of the Carnegie Foundation.

IN the issue of the *Physikalische Zeitschrift* for November 15, Prof. E. Warburg gives a sympathetic account of the life and scientific work of his former assistant and colleague, Karl Richard von Koch, who died a short time ago after having resigned the professorship of physics at the Stuttgart Technical School in 1919 owing to heart trouble. Prof. Koch was born at Stettin in 1852, and after studying at Bonn, Freiburg and Göttingen, graduated Ph.D. at Freiburg in 1875. While librarian there he commenced research in physics under Warburg, and was appointed lecturer in physics in 1881 and extra professor in 1886. In 1888 he became professor at the Aachen, and in 1891 at the Stuttgart Technical School. Here he designed the new Physical Institute, opened in 1910, which has since served as a model of what such an institute should be. His scientific work lay mainly in the direction of improving methods of measurement, especially in elasticity, but he took great interest in the application of physical principles to practical problems and to natural phenomena. His best-known researches are probably those on the elasticity of metals at high temperatures, on the determination of gravity, and on the auroræ.

WE regret to announce the following deaths:

Prof. S. A. Beach, professor of agriculture at Iowa State College, who was known for his work on apple growing and whose name is included in the list of honorary and corresponding members of the Royal Horticultural Society, on November 2, aged sixty-four.

Mr. Alfred H. Brooks, for twenty years chief of the Alaskan Division of the United States Geological Survey, on November 21, aged fifty-three.

Dr. E. Hedinger, professor of pathological anatomy and histology in the University of Zurich, and formerly of the University of Basle, who, in 1914, undertook a special mission to South Africa to investigate trypanosomiasis in cattle, on December 24, aged forty-eight.

Dr. Theodore Hough, dean of the medical department and for seventeen years professor of physiology in the University of Virginia, who worked on the factors regulating breathing and on related subjects, aged fifty-nine.

Mr. A. H. Savage Landor, well known as a traveller and explorer in Tibet and China and also in South America, on December 26.

Mr. F. G. Newton, director of the Egypt Exploration Society's excavations in Egypt, on December 25, aged forty-six.

Dr. B. R. G. Russell, of the Imperial Cancer Research Fund, who made noteworthy contributions to our knowledge of tumour transplantation and of the respiration and carbohydrate metabolism of normal and cancerous tissue, on December 22, aged forty-four.

Current Topics and Events.

IN the *Times* of November 14 a special correspondent in Berlin, dealing with the disarmament of Germany, stated that the German intention "to increase the frightfulness of war by new methods" was finding "its expression in the creation of a great laboratory attached to the Kaiser Wilhelm Institute near Berlin, the object of which is to study war from the scientific point of view." "This mysterious, powerfully equipped, and strongly financed laboratory," it was added, "works in close contact with several parallel institutions scattered over Germany, and especially with the Gas Testing Institute in Hanover." This allegation has been met by a letter from Dr. H. Freundlich, the Deputy Director of the Kaiser Wilhelm Institute, refused, he states, by the *Times*, and so published in the *Berliner Tageblatt* of December 16. Dr. Freundlich states, in the most explicit terms, that neither in the Kaiser Wilhelm Institute for Physical Chemistry and Electrochemistry, nor in any other Institute associated with the Kaiser Wilhelm Society, is there any work in progress that has the purpose of developing war from the scientific point of view, and that all work there undertaken is exclusively scientific and technical investigation for the industries of peace, and having nothing to do with the purposes of war. Finally, Dr. Freundlich invites the correspondent of the *Times*, accompanied by any expert he may choose, to visit the Kaiser Wilhelm Institute, so that he may investigate fully the situation and the character and purpose of the work which is being there carried out. We cannot, of course, know the considerations which led the *Times* to decline to publish this very emphatic repudiation of a serious charge, yet it seems highly desirable that the invitation of the Deputy Director of the Institute should be accepted, and the results made known in Great Britain. What can be credited to our late enemies should be credited, and if there could be an assurance that the great Institute, which was, and is still, presided over by Dr. Haber, is now entirely detached from scientific work relating to warfare, it would be welcome news to all who are waiting for additional signs of a real regeneration of Germany in heart as well as in economic prosperity.

IT is unfortunate that the mere mention of the word atom in a scientific lecture to which reporters are admitted now usually leads to sensational statements in the daily press, much to the annoyance of the lecturer and the detriment of scientific truth. This happened last week in connexion with a lecture delivered at the University of Leeds by Prof. R. Whiddington during a meeting of the Science Masters' Association. The lecture consisted merely of a general account of the present position of atomic physics with special reference to the work of Rutherford and Bohr. Prof. Whiddington's allusions to his own work were made to indicate the lines along which investigation into X-ray electrons and vacuum discharges was being attempted in the University of Leeds, and to give those members of the audience who so wished, an opportunity of seeing the kind of apparatus used. It is scarcely necessary to say that no extravagant claims of the kind suggested in a London newspaper were put forward by Prof. Whiddington or implied in what he said, and the most charitable explanation of the fantastic account published is that the reporter could not sufficiently well comprehend a lecture delivered to an audience consisting mainly of university graduates in science.

THE following presidents and recorders have been appointed for the meeting of the British Association to be held at Southampton on August 26-September 2: *Section A* (Mathematics and Physics)—President: Dr. G. C. Simpson; Recorder: Prof. A. M. Tyndall, University, Bristol. *Section B* (Chemistry)—President: Prof. C. H. Desch; Recorder: Dr. H. McCombie, King's College, Cambridge. *Section C* (Geology)—President: Dr. W. G. Miller; Recorder: Prof. W. T. Gordon, King's College, Strand, W.C.2. *Section D* (Zoology)—President: Mr. C. Tate Regan; Recorder: Mr. F. Balfour Browne, Dysart House, Luard Rd., Cambridge. *Section E* (Geography)—President: Mr. A. R. Hinks; Recorder: Dr. R. N. Rudmose Brown, University, Sheffield. *Section F* (Economic Science and Statistics)—President: (not yet appointed); Recorder: Prof. H. M. Hallsworth. *Section G* (Engineering)—President: Sir Archibald Denny, Bart.; Recorder: Prof. F. C. Lea, University, Sheffield. *Section H* (Anthropology)—President: Dr. T. Ashby; Recorder: Prof. H. J. Fleure, University College, Aberystwyth. *Section I* (Physiology)—President: Prof. A. V. Hill; Recorder: Dr. J. H. Burn, Felden Close, Boxmoor. *Section J* (Psychology)—President: Prof. C. Spearman; Recorder: Dr. Ll. Wynn Jones, 7 St. Mary's Avenue, Harrogate. *Section K* (Botany)—President: Prof. J. Lloyd Williams; Recorder: Mr. F. T. Brooks, 31 Tenison Avenue, Cambridge. *Section L* (Educational Science)—President: Dr. W. W. Vaughan; Recorder: Mr. C. E. Browne, Christ's Hospital, West Horsham. *Section M* (Agriculture)—President: Dr. J. B. Orr; Recorder: Mr. C. G. T. Morison, School of Rural Economy, Oxford.

OF the many recent efforts made by British manufacturers to establish a home industry in the production of colouring matters, one of the most successful has been the enterprise started under the wise inspiration of Mr. James Morton, of the Morton Sundour Fabrics, Ltd., of Carlisle. Until 1914, this firm was entirely a dye-using undertaking dependent on continental sources for its supply of fast dyes. The stoppage of German supplies of colours consequent on the outbreak of war led Mr. Morton to turn his attention to the production of these essential dyestuffs, and, gathering together a group of chemists, he encouraged them to work out the difficult problem attendant on the large-scale production of modern vat colours, a group of chemical substances having highly complicated constitutions. By the end of 1915, the intricacies of indanthrene blue and flavanthrene (indanthrene yellow) had been unravelled, and these colours were being turned out on a manufacturing scale. Other dyes of the same class speedily followed. These persevering investigations were not, however, restricted to the imitation of foreign products. The chemists of the Sundour factory, with commendable initiative, extended the scope of their work to the search for entirely new colouring matters. Here again they achieved a noteworthy success in the discovery of a new group of dyes, known as the Caledon Jade-green series, for the typical representative of this group is unsurpassed for fastness and colouring power.

A FURTHER important development is now announced from Scottish Dyes, Ltd., an offshoot of the Sundour firm. Processes have been discovered for rendering soluble the anthraquinone vat colours, in this way overcoming one of the disadvantages attending the use of these insoluble dyes. The process is being applied particularly to Caledon Jade-green, and the improved product is known as Soledon Jade-green. Similar soluble colouring matters can be obtained from other vat dyes of the anthraquinone series and render it possible to apply these colours to cotton and wool equally. In the case of the latter textile, this application will lead to a marked increase in the fastness of dyed woollen fabrics. The above-mentioned developments taken in conjunction with the industrial success which has crowned the recent investigations of chemists in other British colour factories demonstrate conclusively that scientific research is not merely a necessary but a profitable form of expenditure in all commercial undertakings dealing with chemical products.

AMONG the activities of the League of Nations, which celebrated its fifth anniversary on Saturday, January 10, are several of particular interest to workers in pure and applied science. The Transit Organisation of the League is engaged in work on matters concerning road traffic, inland and maritime navigation, telegraph, telephone and wireless facilities, calendar reform, etc. In the past year the Health Organisation has, in the words of the Fifth Assembly, " extended its sphere of action, improved, completed and defined its technical equipment, and is thus carrying out with increasing success its special task, which is to give effective help to the various national administrations in their campaign against epidemics and their attempts to improve public health." The Committee on Intellectual Co-operation, to which Prof. Einstein has returned, and M. Lugones, a distinguished Argentine *savant*, has been added, is organising and developing its work on bibliography, exchange of publications, inter-university relations, and the pooling and distribution of scientific information. This Committee held an extraordinary session in Paris on Monday, January 12, under the presidency of M. Henri Bergson (France). Prof. Gilbert Murray represented Great Britain, and other members of the Committee include Prof. Einstein (Germany), Mme. Curie (Poland), M. Jules Destrée (Belgium), Sir J. C. Bose (India), and Prof. R. A. Millikan (U.S.A.). The principal item on the agenda was the question of the organisation of the International Institute for Intellectual Co-operation, which was recently offered to the League by the French Government. The proposed Institute, which is to be established in Paris, will be under the direction of the International League Committee in Geneva, and it will be the duty of this Committee to draw up such rules and regulations for its organisation as will safeguard the international character of the Institute.

THE British Broadcasting Company's new high-power station 5XX is being constructed at Daventry, Northamptonshire. The site of the new station is in open country, about 600 feet above sea-level, and 400 feet higher than the surrounding land. A " T " aerial will be used, and an 800-foot and a 500-foot mast are being erected, the transmitter being situated directly under the centre. The antenna has been designed so that its natural wave-length should be about 1600 metres, which is to be the wave-length used for transmission. The power rating is nominally 25 kilowatts, but the actual power used at the station will be 100 kilowatts. The earth system consists of a circular metal plate laid underground and has a radius of 100 feet. It will be connected with the London studio 2LO by means of an overhead telephone line, but an emergency underground cable will also be installed. It is expected that good crystal reception will be obtained up to a radius of about 100 miles. Transmissions will take place in the afternoon and evening. Special programmes of its own will be provided two days of the week, a relayed provincial programme on a third day, and relays of the London programme for the remainder of the week. The first programme will take place in a few months' time.

IT is evident that the visit of the Parliamentary Commission to East Africa, referred to in our leading article of January 10, has had some effect in directing the attention of the colonial governments to the cause of scientific research. By a happy coincidence, while Major A. G. Church was making a plea for greater encouragement for scientific institutions at the St. Andrew's Dinner at Mombasa, the Governor of Kenya Colony, Sir Robert Coryndon, at the corresponding function in the capital, made the same appeal and made use of the same illustration, namely, the Amani Institute. He stated that Kenya Colony is much behind the times so far as scientific research is concerned, and particularly in the investigation of human and animal disease, in botany and in ethnology, and there is lack of co-ordination amongst the East African Colonies on such questions. Sir Robert said that scientific workers in Kenya are too few, that they are working under very difficult conditions, and he would welcome the establishment of a central laboratory in which scientific problems could be properly attacked. Regarding the Amani Institute of Tanganyika, he deplored the fact that nothing has been done since the War to develop the work begun by the Germans, and upon which many thousands of pounds was spent by them. In paying a tribute to the work of Dr. van Someren, who was responsible for the building and the collections of the Natural History Museum of Nairobi, the Governor made an appeal for the support of public-spirited men for the upkeep and improvement of that institution, laying stress on the fact that the cultural aspects of life must play an increasingly important part in the affairs of Kenya Colony.

A PARTY of 32 undergraduates from the Engineering Departments of the University of Cape Town are at present on a tour in England. Accompanied by eight members of the staff, including Profs. Bohle, Plant, McMillan, Snape, and Boyd, they arrived in London on December 31, and their stay will extend over five or six weeks. The objects of the tour are to bring the students into close touch with British manufacturers and to give them a broader outlook on life in general. The whole trip has to be completed within the long summer vacation. The first fortnight has been spent in the London district, where, in addition to visiting the historic buildings, special visits have been made to the National Physical Laboratory, Science Museum, Woolwich Arsenal, and to some important firms. From London the party proceeds to Birmingham, Manchester, Preston, Liverpool, Newcastle, and Sheffield. Each student has to submit a report of the tour which, if the professor of mechanical engineering considers satisfactory, will count in lieu of the six weeks' vacation workshop course usually taken in the summer. Many of the students from Cape Town after finishing their four years' course come to England for experience in works, and remain here. While there are a fair number of openings for civil engineers in the Public Works and Irrigation Department of the Union Government, it is more difficult for electrical and mechanical engineers to find employment in the colony. In organising this unique tour, the Dean of the Faculty of Engineering, Prof. H. Bohle, has been assisted by the staff of the High Commissioner of the Union of South Africa and the officials of the Union Castle Mail Steamship Company, and as a result it has been possible to carry out the complete trip, lasting twelve weeks, for 65*l*. a head.

THE disappearance of seals of economic value from their more accessible breeding-places, under the pressure of the seal-hunter, has intensified their destruction in more remote areas. From some of these they have already been exterminated—the fur-seals (*Arctocephalus australis*) and sea-elephants (*Macrorhinus leoninus*) of Gough Island have all but gone—and there is a danger that in their other southern haunts such seals and the less valuable Weddell, crab-eating, and Ross's seals of the Antarctic circle may ultimately be reduced to the vanishing point. We therefore welcome the announcement (*Times*, January 6) that the French Government has decided to create a preserve for seals and for penguins, which are destroyed wholesale in some areas for their feathers and oil, on the territories belonging to France in the Southern Ocean. These include Kerguelen, the Crozet Archipelago, St. Paul and Amsterdam islands, and the Adélie Land sector of the Antarctic continent. In these areas the destruction of seals and penguins will henceforth be illegal. The crux of the efficacy of animal sanctuaries, however, lies in the proper enforcement of the law, and we doubt whether the policing of these widely scattered scheduled areas by naval patrols based on Madagascar, as is proposed, will be so thorough as one could wish to see.

EVERY one familiar with astronomical and other optical instruments will see with regret the announcement that the old-established firm of Sir Howard Grubb and Sons, Ltd., St. Albans, and formerly of Dublin, has gone into voluntary liquidation, and is for sale. The business was founded in Dublin early in the nineteenth century by Sir Howard Grubb's father, the late Mr. Thomas Grubb, F.R.S., who was engineer to the Bank of Ireland and designed and constructed the machinery for the manufacture of the bank notes. Although made seventy or eighty years ago, this machinery was still in use four or five years ago and probably is so still. A number of machine tools, such as lathes, planing, engraving, wheelcutting and dividing machines, were made by the firm, as well as many portrait lenses. The works were moved from Dublin to St. Albans in 1918 in connexion with the manufacture of periscopes for British submarines. Among the important astronomical instruments made by the firm are the following: 27-inch refractor and dome for Vienna; 26-inch photographic refractor for Greenwich; 24-inch photographic refractor with 18-inch guiding telescope for Cape Town; and a similar instrument for the Radcliffe Observatory, Oxford, with dome and rising floor; 26-inch refractor for Johannesburg; mounting for 24-inch refractor for Santiago, Chile; 40-inch reflector for Simeis, Crimea; 7-metre solar spectrograph for Pulkovo; the 13-inch photo telescopes with 10-inch guiders for the International Photographic Survey of the heavens, erected at Greenwich, Oxford, Dublin, Cork, Capetown, Mississippi, Melbourne, Tacubaya (Mexico), Perth (W.A.), etc. It is greatly to be deplored that a firm with such a record of splendid work, and a reputation so high among optical instrument manufacturers, should have lacked sufficient support to keep it in existence as a profitable concern.

THE late Prof. John Milne, the distinguished seismologist, was among those commemorated a few days ago in a ceremony at Tokyo in honour of living and dead foreign benefactors of Japan.

A SERIES of six Hunterian lectures on "Recent Discoveries of Fossil Man" will be delivered by Sir Arthur Keith at the Royal College of Surgeons of England on January 19, 21, 23, 26, 28, and 30, at 5 o'clock each day.

THE Council of the Geological Society has this year made the following awards:—*Wollaston Medal*: Mr. G. W. Lamplugh; *Murchison Medal*: Dr. H. H. Thomas; *Lyell Medal*: Mr. J. F. N. Green; *Bigsby Medal*: Mr. C. W. Knight; *Wollaston Fund*: Dr. A. Brammall; *Murchison Fund*: Dr. A. E. Trueman; *Lyell Fund*: Dr. J. A. Thomson and Dr. W. A. Richardson.

WITH reference to the note in our issue of January 10, p. 60, on the proposed motor tours across the western Sahara to Timbuctoo, organised by Citroën Cars, Limited, it is announced that as absolute security cannot be relied upon along the Colomb-Bechar—Timbuctoo route, the opening of the service between the two points has been suspended for a period of at least one year.

APPLICATIONS are invited by the Metropolitan Asylums Board for the two following appointments, namely, the directorship of the board's pathological services and that of their diphtheria antitoxin establishment. Particulars of the appointments and forms of application can be obtained from the Clerk of the Board, Victoria Embankment, E.C.4. The completed forms must be received not later than the morning of Wednesday, January 28.

APPLICATIONS are invited for the post of an assistant agricultural chemist for the Division of Research, Lands and Forests Department, Sierra Leone. Candidates must hold an honours degree in natural science (chemistry being the principal subject), or associateship of the Institute of Chemistry, and a diploma in agriculture. Further particulars and the form of application are obtainable from the Private Secretary (Appointments), Colonial Office, Downing Street, S.W.1.

MR. RICHARD H. BURNE has been awarded the Honorary Medal of the Royal College of Surgeons of England for "services rendered to the advance of biological knowledge." Mr. Burne has greatly extended the Department of Comparative Physiological Anatomy in the Museum of the College, of which department he is the Curator. The medal thus awarded, although founded in 1802, has been awarded only eleven times previously. The list of former recipients includes the names of Sir Richard Owen, Sir James Paget, Lord Lister, and of Sir R. Havelock Charles.

Our Astronomical Column.

THE SOLAR ECLIPSE OF JANUARY 24.—This eclipse cannot be regarded as of great importance for the study of solar physics, owing to the unfavourable season of the year, and the rather low altitude of the sun at all the land portions of the track of totality. The eclipse derives some interest, however, from the populous regions which it traverses in Canada and the N.E. corner of the United States, including some outlying districts of New York.

Efforts have been made to induce the general public to join in the observations; in particular, to note the exact duration of totality at numerous points close to the northern and southern limits. This will enable the exact position of the lunar node to be determined, as Newcomb did from similar observations in England in 1715. Numerous observatories lie within the totality track, so that full advantage will be taken of any opportunities for useful work that weather conditions may afford. The altitude is too small for study of the Einstein shift, which was, moreover, dealt with sufficiently in 1922.

The eclipse has some interest in the British Isles from the fact that, after a barren interval of two centuries, there is a very near approach to totality at St. Kilda in the Western Hebrides. The sun's altitude is, however, insufficient for any useful work, and landing on St. Kilda is generally difficult in winter. There is a large eclipse throughout the British Isles, beginning about $14^h\ 45^m$, and greatest phase an hour later. The magnitude reaches 0·94 at Glasgow, 0·82 in London.

It would seem that the only observation of value that can be made in Britain is the careful timing of the first contact. Dr. Innes proposed a useful method of improving the determination by frequent measures of the distance between the cusps for the first minute or so. If the projection method be employed, two observers can mark on the screen the positions of the North and South cusps at prearranged beats of the clock. This method was found practicable at Greenwich in April 1921.

WOLF'S COMETARY OBJECT OF DECEMBER 22.—Observations of this object on December 22, 23, 25, 26 are now to hand. Dr. A. Kahrstedt, of Berlin-Dahlem, has deduced the following (still very uncertain) elliptical orbit from the first 3 positions (Copenhagen Circular, No. 56).

T	1925 March 27·7308 G.M.T. (new)
ω	219° 32′ 38·0″
Ω	264 47 14·8
i	14 47 11·3
ϕ	40 27 44·4
μ	319·231″
log a	0·69726
Period	11·12 years.

The magnitude is estimated as 16. The approach to the sun will probably cause a slight brightening, but the distance from the earth is increasing. The object will remain observable for some months.

EPHEMERIS FOR GREENWICH MIDNIGHT.

	R.A.	N. Decl.
Jan. 14·0	$4^h\ 6·4^m$	20° 0′
22·0	4 10·2	18 38
30·0	4 16·4	17 29
Feb. 7·0	4 25·0	16 31

The object is in Taurus, moving towards Aldebaran. The elements have some resemblance to those of Faye's Comet, due at perihelion next September. Identity, however, does not appear to be possible.

INTERESTING GROUP OF MORNING STARS.—Mr. W. F. Denning writes: "On the morning of Thursday, January 22, the south-eastern sky before sunrise will display the planets Mercury, Venus, and Jupiter, and the crescent of the moon in near companionship. The picture will be a rare and interesting one, but it will not be easy to observe; for the planets involved will rise at about 6 h. 35 m., and this is only 1 h. 20 m. before the sun. They will be placed, therefore, very near the horizon, and will require a favourable atmosphere at low altitudes in order to be well seen. If the observer occupies a position commanding a good open view of the south-east, and if weather conditions are good, there should not be much difficulty in detecting the various objects, though twilight will be strong. The best time to look for them will be at about 7 A.M. or a little afterwards. Of the planets, Venus will be the most brilliant, Jupiter being next, and Mercury last in the order of magnitude."

Research Items.

ARCHÆOLOGICAL EXPLORATION IN FLORIDA.—Mr. J. Walter Fewkes has been able to take advantage of the commercial exploitation of Weeden Island, Tampa Bay, to explore the shell mounds, which were noted nearly half a century ago as a prominent feature of this part of Florida, but have now to a great extent disappeared owing to the use of their material for road metal. In vol. 76, No. 13, of the Smithsonian Miscellaneous Collections, Mr. Fewkes describes and figures remains found in a preliminary exploration on Weeden Island, which was mainly directed to the investigation of a mound which had been used as a cemetery. The prehistoric aborigines appear to have lived principally on shell fish, but they also ate fish, game, and rodents, and, possibly, roots and fruits. The mound exhibited three layers of stratification, one being modern. In the upper of the two ancient strata, skulls and skeletons occur in numbers, and the implements and a finely decorated pottery point to a relationship with the prehistoric inhabitants of Northern Florida and Southern Georgia. The lowest stratum contains objects belonging to an ancient people of Florida whose origin and affinities are obscure, but whose pottery suggests affinity with the archaic pre-Tainan Ciboney culture of Cuba and the similar early cultures of other West Indian Islands. Whether it was autochthonous in both areas or an extension from one to the other is a question for future investigation.

CLASSIFICATION OF CONSCIOUSNESS.—The presidential address to the Section of Psychiatry, Royal Society of Medicine, delivered by Dr. C. S. Myers, has been printed in the *Lancet* of November 29. Dr. Myers puts forward certain views and aspects, derived from a study of pure psychology, in the hope that they may prove interesting and suggestive to those working in the applied field of medical psychology. He reviews some of the more fundamental problems of psychology, which have of recent years been less frequently considered than before the War, owing to the urgency of more practical problems. Nevertheless it is wise at intervals to view the more abstract problems. Dr. Myers considers the conception of consciousness and discusses the difficulties involved in the usual classification into the three modes, namely, the cognitive, conative, and affective, and offers an alternative scheme. He then outlines the part played by consciousness and shows that its function is to select both from alternative responses and alternative stimuli so as to maintain an environment—whether physical or mental—that shall be favourable, and to avoid one that is unfavourable. For this to be possible, it is necessary that relatively small variations in the environment should differ in the reactions evoked. He shows how the vague complex precedes the differentiated simple and the part played by the power of projection, *i.e.* the ability of the self to regard its own change of states as something outside itself. The reflex act is interpreted not as an original type out of which more complex forms of activity have evolved, but as a decadent form of mental activity. Dr. Myers concludes with a discussion of the relation of consciousness to the brain, and points out that the recent developments of physical science have rendered the difference between mind and matter a different problem from what it was a hundred years ago.

THE BIOGENETIC LAW AND THE GYMNOSPERMS.—The very characteristic and stimulating paper that Prof. E. C. Jeffrey of Harvard read before Section K of the British Association at Toronto, and at Edmonton, is printed in *Science* (vol. 60, No. 1563, December 12, 1924), and will certainly arouse interest amongst European botanists, possibly provoking the retort courteous, from the European view-points so vigorously assailed. To Prof. Jeffrey, the higher plants provide excellent examples of the validity of the doctrine of recapitulation, their witness being free from the obscurities introduced by "larval forms." He cites particularly the normal leaf form to be found in seedling stages of xerophytic Cacti, Veronicas, etc., as also the typical leaves on seedlings of plants later armed only with phyllodes or phylloclades, and the prevalence of the typical evergreen needle upon the seedling conifer, although later these plants may be deciduous, as on larch, or bear leaves confluent with the surface of the stem, as on the arbor vitæ. Prof. Jeffrey then proceeds to discuss the anatomy of living and fossil forms amongst Gymnosperms, and thus finds evidence for three "working principles," namely, (1) recapitulation; (2) the doctrine of retention (instanced by conservative organs, namely, root and reproductive axis); (3) the doctrine of reversion as a result of injury. In analysing the anatomical and fossil data along these lines, Prof. Jeffrey fights over again the phyletic battle of Araucarian phylum versus Abietinean as competitors for ancient standing amongst Gymnosperms, and concludes once more that "when the dust of conflict has settled, it will probably appear that Ginkgo and Pinus stand side by side as the prototypes of Mesozoic gymnosperms of Cordaitean derivation. It will then be realised that Agathis and Araucaria are aberrant extremes, which merely simulate Cordaites on the basis of extremes meeting but have no near affinity with them."

THE COOLING OF THE EARTH.—In the Journal of the Washington Academy of Sciences for December 4, 1924, Leason H. Adams, of the U.S. Geophysical Laboratory, presents a very welcome discussion of the distribution of temperature at moderate depths within the earth. He adopts the method initiated by Holmes in 1915 of utilising the age of the earth as a known factor in the problem. This makes it possible to determine the relative importance of the heat generated by radioactive disintegration, and thus to calculate the internal temperatures from an assumed initial molten state. Cooling at first is controlled almost entirely by convection giving a thermal gradient of nearly 1° C. per km. Convection is gradually terminated either by crystallisation, leading to a gradient of 2·5° to 5° per km.; or by increasing viscosity, leading to a gradient less easily calculable, but lying within the range 1° to 10° per km. As a probable average, 4° per km. is adopted for the final computations. These are based on the assumption that below the outer 100 km. the material produced by crystallisation-differentiation would be peridotite; a diabasic zone forming above; and finally a granitic layer. The important principle is then established that on account of the great age of the earth (1600 million years), the temperatures at depths greater than 100 km. are unaffected by any reasonable variation of the initial temperatures in the upper 100 km. For the purpose of calculation, an initial surface temperature of 1200° C. has commonly been adopted (*e.g.* by Holmes and Jeffreys), and it has been argued that, as the surface was probably of granitic composition, a much lower initial temperature would more accurately fit the conditions. However, as the present temperatures depend on the original temperatures at considerable depths, it is easily seen that 1200° C., far from being too high, is more probably too low. The author takes 1400° C., the melting-point of peridotite, as the effective initial temperature, and gives a temperature curve down to 300 km., which is the best representation of the probable average thermal conditions under the continents yet available.

The Photoelectric Primary Current in Crystals.—A paper by Messrs. B. Gudden and R. Pohl, in the *Zeitschrift für Physik*, December 6, deals mainly with the positive portion of the photoelectric primary current which is produced by the action of light of long wave-lengths, or thermal molecular movements, on a crystal in which light of short wave-length has caused a flow of electrons to the anode, leaving the positive ions in their original positions in the lattice. The effect has been studied in diamond, with light of a number of different wave-lengths produced by a monochromator, and it appears that wave-lengths of 630-660 $m\mu$ are most effective in producing it. The optical absorption of diamond extends farther towards the red, when the disturbances in the lattice are increased by the positive charges which remain fixed in the lattice after the negative portion of the photoelectric primary current has passed. The authors formerly regarded the primary current as being wholly due to this flow of electrons to the anode; but they now include the positive portion of the current in this term. With blue light, for example, it is shown that part of the primary current is due to the flow of electrons, without inertia, and part to a shifting, step by step, of the resulting positive charges towards the cathode, due to thermal molecular movements. These facilitate the passage of an electron from a neutral atom to the positive ion standing next to it on the side towards the anode. It is probable that, so far as the conductivity mechanism is concerned, the photoelectric phenomenon can be dealt with in the same manner, not only in other crystals in the author's first group, with refractive indices more than two; but also in second group crystals, such as sodium chloride which has been treated with X-rays.

Magnetism of the Coils of Moving Coil Galvanometers.—It has been known for many years that the magnetic properties of the materials used for the suspended systems of moving coil galvanometers have much to do with the troublesome "zero shift" which often greatly increases the labour of the observer. The British Scientific Instrument Research Association (26 Russell Square, London, W.C.1) has, therefore, done good work in publishing a careful investigation (price 6*s*.) on this subject by Mr. G. Williamson. The author finds that zero shifts can be divided into two kinds: first, those due to temperature changes and, secondly, those following upon deflexions of the coil. The first cause is due to variations in the elastic constants of the suspended strips. The second cause is due to the permanent magnetism of the constituents of the coil. The author makes an exhaustive study of this second cause. He uses two methods of obtaining rough comparative estimates of the permanent magnetic properties of similar specimens. In the first method, he magnetises the specimen by a known strong field and then measures the couple exerted on it by a weaker field perpendicular to the direction of magnetisation. In the second method, he measures the zero shift of the specimen following on a deflexion in a known constant field. He finds that all the materials forming the galvanometer coil—silver wire, wooden former, silk insulation, the mirror itself—showed permanent magnetism. Of the resultant effect, 18 per cent. was due to the wooden former, 33 per cent. to the silk insulation, and the remaining 49 per cent. was due to the silver wire, mirror, binding wires, etc. Some of the effects due to the silver wire could be minimised by heating it in concentrated hydrochloric acid, and the ferro-magnetic effects due to the wooden formers could be diminished by exposing them to hydrochloric acid gas. The silk insulation was much the most difficult to deal with. It was found that the ratio of zero shift to sensitivity diminishes as the magnetic field (*i.e.* the sensitivity) increases.

Beeswax.—The production, properties and uses of beeswax are described in the *Chemical Trade Journal* for December 12, 1924. Beeswax is formed voluntarily by the bees loading their stomachs with honey and then resting in clusters perfectly still for twenty-four hours. Owing to the introduction of artificial honeycombs in bee culture, European countries have failed to cope with the modern demand, and large quantities of wax are imported from Africa, the West Indies, and Portugal. The imported material is mostly produced by wild bees and is inferior to the product obtained from the home-cultivated bee. The wax is often bleached by exposure to the sun or ozone (extensively used at Leningrad) or by other oxidising agents. The principal constituents are myricyl palmitate and cerotic acid; smaller quantities of myricyl and ceryl alcohols, psyllostearyl alcohol, melissic acid, many hydrocarbons (*e.g.* heptacosane hentreacontane) and unsaturated acids are also present. The physical properties are described in detail, a table of constants being given.

Synthetic Sweetening Compounds.—The chemistry of synthetic sweetening compounds is reviewed by G. M. Dyson in the *Chemical Age* for December 6, 1924. The recent researches of Cohn and Holleman are described. The introduction of halogen and other groups into saccharin has the following general effects. The sweetness increases with decreasing molecular weight of the entering halogen group, though nearly all halogen derivatives have a bitter after-taste. 6-Chlorosaccharin is more than half as sweet as saccharin itself, and is sweeter than the 4- and 5-chloro-derivatives. Whereas 4-amino-saccharin is sweeter than saccharin, 4-nitrosaccharin is bitter. The introduction of alkyl groups has little or no effect, though the after-taste is modified. Multiplication of sweetening groups is not always associated with an increase of sweet taste. Sternberg has pointed out that for an aliphatic compound to be sweet, the alkyl groups must not outnumber the hydroxyl groups by more than one; further, the sweetness of an aliphatic compound increases with the number of hydroxyl groups present. Oertly and Lyers have proposed a theory of taste akin to the colour and constitution theory, but the rules are more often broken than followed. Mr. Dyson describes in some detail the preparation of saccharin, and mention is made of "dulcin" and "methyl-dulcin," which are *p*-phenetyl urea and *p*-anisyl urea respectively.

Conductivities of Electrolytes.—Researches on measuring the conductivities of electrolytes by the induced magnetic field method of Guthrie and Boys have recently been carried out by O. Scarpa (*Gazzetta Chimica Italiana*, November 1924). Adopting this method the author investigates the electrical resistance of, and the influence of a magnetic field on, an electrolyte in motion. The action of a magnetic field on a jet of an electrolyte carrying a current is also described.

The Physical and Optical Societies' Exhibition of Apparatus.

THE fifteenth annual exhibition of apparatus held by the Physical and Optical Societies at the Imperial College of Science and Technology, South Kensington, brought to light a larger number than usual of novel and improved instruments. The standard of workmanship and finish was everywhere high, and it was a pleasure to note that the products of British firms, to which the exhibition was primarily devoted, compare very favourably in these respects as well as in ingenuity and soundness of design with imported goods of a similar character. There was a preponderance of instruments for industrial purposes and for advanced research: a certain number of firms also showed apparatus suitable for educational laboratories, but a greater proportion of apparatus of this type would be welcome at such an exhibition. Special interest also attaches to disassembled instruments: a brass box with knobs is impressive rather than instructive.

In briefly discussing some of the exhibits it is impossible to do justice to most of the stands, which could not be adequately studied in an exhibition lasting only two days. It will be necessary to make an arbitrary selection of apparatus which appeared to be specially interesting on account of its novelty, and to pass over without mention a majority of items the intrinsic importance of which is at least as great.

The most sensational feature of the exhibition was Mr. C. F. Elwell's discourse on "Talking Motion Pictures," illustrated by demonstration films. It must suffice here to remark that no one who saw and heard the demonstration can doubt that the essential problem has been solved, and that for better or worse the talking picture is ripe for commercial exploitation. In addition to other items making for brighter physics, visitors had the piquant experience of being addressed by a very realistic President Coolidge on the American citizen's burden of taxation! An equally interesting discourse and demonstration was given each day by Mr. F. Twyman, who dealt with the Michelson interferometer. In the hands of Mr. Twyman and his assistant, this interferometer became a delicate means for studying temperature distribution in a transparent body: the instrument was so adjusted as to project on the screen a field of substantially uniform colour derived from a source of white light, and on the introduction of the demonstrator's finger into one of the interfering light-beams, lines of colour appeared round the shadow of the finger, these lines representing approximately isothermal contours. Perhaps the most striking of the experiments shown was the "soaking in" of the isothermal lines into a plate of glass when a match had been momentarily applied to the latter, and it was also made possible to "see" petrol vapour poured from a bottle and the lines of strain in glass under stress—the latter application giving effects similar to those which have been obtained by Prof. E. G. Coker with polarised light.

The Cambridge Instrument Company is one of the firms which enters into the spirit of the exhibition and seeks to enhance its interest by the variety of its exhibits and by admirable descriptions given in the programme. The principal *métier* of the firm, the measurement of temperature, was represented by some dial thermometers of the vapour-pressure type, but they were somewhat overshadowed by more intriguing "side-lines." The dial thermometer appears to be displacing the glass thermometer from industry, for Negretti and Zambra also made a feature of thermometers in which a mercury bulb communicates with a dial-control through steel-lined tubing. An interesting improvement in calorimetry is the use of stainless steel in a bomb calorimeter (Griffin). For taking the temperature of buried cables, Siemens measures the resistance of a nickel pilot wire fitted to the latter.

Items of interest to meteorologists included an Assmann psychrometer ventilated by an electrically driven centrifugal fan, shown by Negretti and Zambra. It is to be hoped that this or a similar firm will succeed in solving the hitherto unsolved problem of constructing a self-acting hygrometer with permanent zero: apart from this latter consideration the firm's recording hair hygrometers appear to be fool-proof. A simple and ingenious recording barometer of great sensibility (Hughes) is that designed by S. G. Starling: the mercury bulb is connected to the vertical column of the barometer by a horizontal tube of substantial length, the whole being mounted on a pivoted board hanging in a vertical plane. Movement of the mercury causes the board to tilt, while a pen carried by the board traces a record on a chronometric drum. Short and Mason, by a special design of the linkwork controlling the pen of a barograph, are able to provide the latter with an exceptionally open scale. A novel kind of cloud photograph is taken with the Robin Hill lens (Beck), which has an angle of 180°, so that a photograph of the whole sky can be taken on a single plate. Such a photograph is of value in spite of its distortion, but if necessary a selected section of it can be straightened out by copying with the lens reversed.

Two interesting oscillographs were those shown respectively by Tinsley and Co. and by the Cambridge Instrument Co. The former is of the inertia-less cathode-ray type and employs a hot cathode, high sensibility with low voltage being thus secured. The cathode stream is focussed into a pencil by surrounding the filament with a positively charged sheath. The Cambridge instrument, on the other hand, is an improvement on the Duddell oscillograph and enables simultaneous records to be obtained from three separate vibrators which are replaceable and may be electrostatic or electromagnetic in any combination. Intense illumination is secured by applying a momentary excess voltage to the 4-volt metal filament lamp during and immediately before exposure of the travelling photographic film. The Campbell frequency meter, which aroused much interest when it was recently described before the Physical Society, was also shown by this firm. It depends on a bridge system employing mutual inductances, covers a range of from 200 to 4000 cycles, and attains an accuracy of about 1/10 per cent. Other meters worth noting were a series for various quantities (ammeters, voltmeters, etc.) but uniform exterior by the Weston Electrical Instrument Co. These are of convenient square form but comparable in price with those of less portable design. A very interesting detail of design has been introduced into the Cirscale moving-iron instruments (Record Electrical Co.) in order to secure a pointer movement of 300°. These instruments are of the type in which a pair of soft iron strips inside a solenoid are magnetised by the same field, so that the repulsion between them measures the energising current. In the present instance, two pairs of such strips are used: one member of the first pair is fixed, while the "fixed" member of the second pair is carried round by the moving member of the first pair, the two latter members being rigidly joined together but spaced apart along the axis of the solenoid. The Rayworth's voltmeter (Elliott Bros.) for testing accumulators is provided with a differential winding and a cadmium electrode so arranged that, in addition to ordinary testing, comparison of the potential of each plate with that of the cadmium electrode can be carried out, and further, the unexpended charge remaining in the cell can be measured. The Darimont electric batteries have the interesting feature that the exciting and depolarising solutions are separated by a semi-permeable membrane created by the reaction which takes place between the solutions themselves.

For testing overhead A.C. mains, Crompton and Co. provide a hinged-core transformer. The ring-shaped core is passed over the main and closed so as to surround the latter, which then forms the primary of the transformer, while the winding on the core forms a secondary and enables the current in the main to be tested. Impedance apparatus included the Duwatcon condenser for wireless (Dubilier Condenser Co.), so designed that its range for series connexion slightly overlaps its range for parallel connexion, thus obviating the gap in tuning range which ordinarily occurs when the connexion is changed; and three interesting variometers. Of these the Mansbridge is flat in shape and comprises D-shaped coils: used alone it will cover all the B.B.C. wave-lengths, and in conjunction with a fixed condenser of 0·002 μf will cover wave-lengths up to 1800 metres. A similar range is attained in a variometer by the Marconiphone Co. by means of a series-parallel switch. In the "wound on air" variometers of the Igranic Electric Co. the windings are spherical and entirely self-supported.

Amongst wireless apparatus, the Multivibrator wavemeter designed by D. W. Dye (Sullivan) attracted much attention. In this arrangement a specially constant tuning-fork, maintained in vibration by a thermionic valve, controls by accordance a multivibrator comprising two valves so cross-coupled as to generate oscillations rich in harmonics at approximately the same fundamental frequency as the fork. By selective amplification, harmonics up to the 120th can be picked out and heterodyned with the oscillation the frequency of which is to be measured, and by using two such arrangements in series a harmonic of frequency $1 \cdot 2 \times 10^6$ can be utilised. A complete "public address system" for amplifying speech or gramophone reproductions was shown in action by Marconi's W. T. Co., high-power water-cooled valves as used for broadcast transmission by the M.O. Valve Co., and the newest types of dull-emitter and other valves by the latter, the Mullard Radio Valve Co., and Cossor. A fool-proof emergency wireless transmitter for ships' lifeboats was shown by Evershed and Vignoles.

As regards line telegraphy, it was gratifying to notice a column printer of British manufacture (Creed and Co.): Morse line currents are converted to printed matter arranged in columns like that given by an ordinary typewriter, as in the American instruments which have hitherto held the field. The direct-working sounder of the India Rubber, etc. Works Co. introduces the long overdue reform of replacing the pony sounder by a far more efficient device employing a diaphragm.

A radium clock has been devised by Mr. Harrison Glew the radium for which may be that contained in an ordinary applicator or other container which can be removed from the clock when desired: in fact, the period of the clock may be used as a measure of the quantity of radium in any vessel to which it is connected. An interesting high-voltage high-resistance battery useful in radio-active and ionisation work is the disc battery designed by Major C. E. S. Phillips (Cambridge Instrument Co.). It consists of adjacent paper discs coated with metal foil, is very portable, and is not damaged by short-circuiting. The horrors of the dentist's chair may be shortened by the use of radiography: in the apparatus provided by Watson and Sons all external high tension leads are eliminated for the benefit of dentists untrained in such matters, and for the peace of mind of their patients. A Potter Bucky diaphragm is also provided for cutting out secondary radiation from the patient's body, which otherwise impairs the definition of the radiograph: it consists of a grid of lead plates so arranged as to absorb radiation which deviates from the direct line, and it is kept in motion during exposure so that its shadow does not appear on the film.

A soft-ray tube for crystal work, designed by Shearer, was shown by Hilger connected with a highly efficient evacuating arrangement. This comprised a Hyvac backing pump (on the Gaede model but with optically perfect contact surfaces) in combination with a Vitreosil mercury condensation pump (Edwards and Co.) with a fused silica casing, the over-all speed being about 200 c.c. per second and the ultimate vacuum about 0·000002 mm. An even faster pump is the Kaye-Backhurst, which is all of metal and employs an *annular* jet of vapour from boiling mercury to entrap molecules diffusing from the evacuated space. The speed amounts to some thousands of cubic centimetres per second.

Messrs. Hilger also showed how to use a Lummer-Gehrcke plate in combination with a spectroscope to demonstrate the Zeeman effect, obtaining very clear definition. Other optical items were a Nicol prism of $1\frac{1}{8}$-in. aperture (Bellingham and Stanley); a scaleometer (Ottway and Co.) comprising a pocket microscope with a scale in the focal plane of the eyepiece and an oblique glass plate for illuminating the object; and a rod illuminator (Baker) for microscopes. The latter very curious and effective device consists of a thick glass rod bent to any convenient shape and capable of carrying light by total internal reflection from a light source to a microscope: in fact it forms a kind of hose for conveying light. A selenium photometer (Watson and Sons), recently described by Dr. Toy, has been specially designed for measuring the density of photographic negatives. Two beams of light from the same source reach a selenium cell by different paths, and a screen can be turned so as to cut out one beam and let in the other at the same rate. The negative is interposed in the path of one beam and an adjustable wedge in that of the other, so that when the opacities of these obstructions are equal, no change in the illumination of the selenium cell is produced by turning the screen.

Teachers will be interested to find that kinematograph projectors for private use are coming within the reach of small pockets. A Pathé projector (Baker) can now be obtained at a comparatively moderate price, while a more expensive outfit (Kodak) enables the user to take his own films as well as to project them, the films being reversed to positive without the use of a negative. A Leitz photomicrograph (Ogilvy and Co.) has been so arranged that all the operations necessary in photographing microscopic objects on a whole plate can be performed from a single position of the observer, and the apparatus is suspended on springs while the exposure is actually being made. While discussing optical apparatus it is worth while to note that pointolite lamps can now be obtained for use on A.C. mains.

A very simple planimeter shown by Harling consists of a single rigid piece of metal carrying a tracing point at one end and a hatchet-shaped projection, the plane of which passes through the point, at the other. The point is passed round a closed curve in the ordinary way, and the distance between the positions of the hatchet edge before and after this operation is a measure of the area encompassed. It is claimed that this simple device can give an accuracy of 2 per cent.

Surveying instruments included a tacheometer (Cooke, Troughton and Simms) in which the horizontal distance of a surveyor's vertical scale is given directly, allowance for the slope being made by an automatic cam-operated adjustment of the distance between the stadie lines in the focal plane of the eyepiece with which the image of the scale is compared. Dr. Hutchinson's goniometer (Swift and Son) was also worth noting on account of its versatility: it serves as an ordinary goniometer, an axial angle apparatus, a Kolrausch total reflectometer, and a prism refractometer. An ingenious balance (Oertling and Co.) called the "Chainomatic" dispenses with all weights and riders below 0·1 gm. by employing a chain attached at one end to an arm of the balance and at the other to a pillar which can be raised and lowered to a measured extent without opening the case. The position of the pillar indicates how much of the weight of the chain is being borne by the balance arm. In the tank gauge made by Negretti and Zambra for indicating liquid levels, air is pumped into a tube extending down into the liquid until it escapes from the bottom: the tube is then put into communication with a pressure gauge which registers the head of liquid in the tank. Another instrument of mechanical interest is the recording accelerometer of the Cambridge Instrument Co., in which an eccentric mass, the movements of which are made deadbeat by Foucault-current damping, records accelerations by the "stylus-on-celluloid" method developed by this firm.

A fuller account of many of the exhibits will be found in the December issue of the *Journal of Scientific Instruments* published by the Institute of Physics. The issue is entirely devoted to the South Kensington exhibition.

The following firms participated in the exhibition: C. Baker (optical instruments), R. and J. Beck, Ltd. (optical instruments), Bellingham and Stanley, Ltd. (optical instruments), W. Butcher and Sons, Ltd. (the optiscope projection apparatus and the autoprint photographic enlarger), the Cambridge Instrument Co., Ltd. (thermometric and various precision instruments), the Cambridge University Press, Carbic, Ltd. (the Otis King's calculator), the Chromoscope Co., Ltd. (the mutochrome, for varying the colours in patterns and designs), Cooke, Troughton and Simms, Ltd. (surveying instruments), A. C. Cossor, Ltd. (thermionic valves), Creed and Co., Ltd. (printing telegraphs), Crompton and Co., Ltd. (electric laboratory apparatus), George Culver, Ltd. (opticians' goods), J. H. Dallmeyer, Ltd. (cameras and lenses), the Damard Lacquer Co., Ltd. ("Formite" bakelite synthetic resin products for insulation, etc., the hardness of which is suggested by a humorist to have given rise to the company's name), Darimont Electric Batteries, Ltd., F. Davidson and Co. (optical instruments), the Dubilier Condenser Co. (1921), Ltd. (impedances), Edison Swan Electric Co., Ltd. (pointolite lamps), W. Edwards and Co., Ltd. (vacuum pumps), Elliott Bros. (London), Ltd. (electrical testing apparatus), Everett, Edgecumbe and Co., Ltd. (electric testing apparatus), Evershed and Vignoles, Ltd. (electric tests, wireless, traction recorder for electric trains), Foster Instrument Co. (pyrometers), E. B. Fry, Ltd. (time measuring and lantern slides), A. Gallenkamp and Co., Ltd. (electric furnaces, etc.), Gambrell Bros., Ltd. (electric testing), F. Harrison Glew (radio-active apparatus and cobalt steel magnets), John J. Griffin and Sons, Ltd. (potentiometers, etc.), W. H. Harling (drawing instruments), Adam Hilger, Ltd. (optical and spectrographic instruments), Henry Hughes and Son, Ltd. (compasses, range-finder, etc.), Igranic Electric Co., Ltd. (wireless parts), the India Rubber, Gutta Percha and Telegraph Works Co., Ltd. (telegraph apparatus), Geo. Kent, Ltd. (air, gas and steam meters), Kodak, Ltd. (cameras, etc.), H. K. Lewis and Co., Ltd. (scientific publications), Macmillan and Co., Ltd. (scientific publications), Marconi's Wireless Telegraph Co., Ltd., the M. O. Valve Co., Ltd. (wireless valves), the Mullard Radio Valve Co., Ltd. (Holweck molecular pump and valves), Nalder Bros. and Thompson, Ltd. (electric testing instruments, etc.), Negretti and Zambra (meteorological instruments), Newton and Co. (optical projectors), L. Oertling, Ltd. (balances and the Eötvös torsion balance), Ogilvy and Co. (microscopes and accessories), W. Ottway and Co., Ltd. (surveying instruments, etc.), Record Electrical Co., Ltd. (switchboard apparatus), Ross, Ltd. (optical and photographic instruments), Short and Mason, Ltd. (meteorological instruments), Siemens Bros. and Co., Ltd. (electric thermometry), H. W. Sullivan, Ltd. (high frequency, cable and other electric testing apparatus), J. Swift and Son, Ltd. (industrial microscopes, etc.), H. Tinsley and Co. (electric testing, etc., apparatus), Watson and Sons (Electro-Medical), Ltd. (X-ray apparatus), W. Watson and Sons, Ltd. (optical instruments), Weston Electrical Instrument Co., Ltd. (electric testing apparatus), Wireless Press, Ltd., *The Wireless World and Radio Review*, Wray (Optical Works), Ltd. (cameras, lenses, and the nephelometer for measuring opalescence), Zenith Manufacturing Co. (resistances, etc.).

Annual Meeting of the Science Masters' Association.

THE twenty-fifth annual meeting of the Science Masters' Association was held on January 5, 6, and 7 at the University of Leeds, at the kind invitation of the University authorities. Members were housed at the University Hostels, an act of hospitality which was very much appreciated. The fact that the meeting was held at Leeds gave those members residing in Scotland and the North of England an excellent opportunity of attending, and the number present was very large. The meeting began with a dinner in the Refectory, at which the Association was entertained by the University. Afterwards there was a reception in the Great Hall by the Vice-Chancellor, Dr. J. B. Baillie, and the President of the Association, Sir Berkeley Moynihan, Bart., professor of clinical surgery in the University.

After a delightful speech of welcome by the Vice-Chancellor, which was suitably acknowledged by the chairman of the Association, Mr. E. A. Gardiner (Louth Grammar School), Sir Berkeley Moynihan delivered his presidential address. The subject he chose was the debt which science owes to medicine, and was introduced by an historical survey of the progress of medicine from the earliest days to the present time. Claiming that Hippocrates and Galen were the inventors of the inductive and deductive methods respectively in science, the president passed in rapid review the events of succeeding centuries and astonished his audience by showing how many eminent men of science had been physicians or surgeons. Although, for several centuries, the growth of medicine scarcely kept pace with that of the slowest of her intellectual children, the establishment of pathological anatomy at the hands of John Hunter and others, and, in more recent times, the great work of Lister, finally resulted in the reunion of the two methods of scientific inquiry—observation and experiment—so long divorced in medicine.

After referring to the great difficulty in medicine of obtaining an accurate anamnesis, the president expressed his views on the nature of the help which might be expected from researches carried out in the laboratory. He pointed out that discovery of the cause of a disease, though often extremely valuable, does not necessarily mean that we can immediately effect a cure, or even that we should be able to devise a more efficacious method of treatment. Treatment of tuberculosis, for example, has been very little changed by the discovery and isolation of the tubercle bacillus. In the same way, even if science solves the problem of the cause of cancer, it does not follow that that fell disease will at once become curable. So far as cancer is concerned, indeed, Sir Berkeley said that we should never forget that we already know how to cure it in almost all parts of the body in which it commonly occurs. Nothing in clinical practice is more certain than this—that cancer in the first instance is a local disease, and that, with few exceptions, an early operation for any cancerous growth is attended by only the slightest risk, if indeed by any, and may confidently be expected to confer a permanent immunity from a return of the disease.

The chairman then called upon Prof. A. Smithells, past president of the Association, to move the vote of thanks. Prof. Smithells referred feelingly to the warm friendship which had existed for so long between the president and himself, and expressed the thanks of the Association in very happily chosen words. The vote was seconded by Prof. H. E. Armstrong, who has been a staunch friend of the Association, no less than its tireless mentor, since its inception a quarter of a century ago. The audience showed its appreciation of Sir Berkeley's address by carrying the vote with enthusiasm.

Tuesday morning was devoted to the business meeting, and to lectures given to the Association by Profs. J. H. Priestley, R. Whiddington, and R. W. Whytlaw-Gray. During the afternoon and evening, demonstrations were given in the laboratories by members of the University staff, and tours were made through the Departments of Textile Industries, Leather Industries, Colour Chemistry, and Engineering. Members of the Association expressed great pleasure at the laboratory demonstrations, where they obtained many new ideas for their own courses at school. Special mention must be accorded to the delightfully simple apparatus devised for showing the Brownian movement in tobacco smoke, which attracted a great deal of attention and requires nothing more elaborate than two good microscope objectives and a suitable source of light.

On Wednesday there was a fruitful discussion on the connexion between science teaching in schools and universities, in which both sides were well represented. The discussion was opened by Prof. Smithells, who was followed by Dr. Terry Thomas (Head Master of Leeds Grammar School), Mr. F. S. Young, Mr. Willings, Mr. F. B. Stead (H.M.I.), Prof. W. P. Milne (University of Leeds), and others. In the afternoon, excursions were made to the Leeds Forge, the Yorkshire Copper Works, the Yorkshire Iron and Coal Co., Ltd., the West Ardsley Collieries, Messrs. Ackroyd and Best (glass-blowing), the Prospect Mills (spinning, weaving, dyeing, and finishing), and Messrs. J. Nicholson and Sons, Ltd. (sulphuric acid works). The educational importance of these visits, which enabled members to realise more closely the relationship between science and industry, can scarcely be exaggerated, and thanks were expressed to the various firms for their kindness in receiving the Association.

During the whole of the meeting there were excellent exhibitions of books, chemicals, and scientific apparatus by the leading firms, among which the exhibit by the local house of Reynolds and Branson may be specially noted. There was also a stall devoted to books written by members of the Association, which testified to their literary activity. A noteworthy feature was a list of books suitable for school science libraries, which should prove of great value to those engaged in teaching science in schools.

It was announced that the Bishop of Birmingham had been asked, and had agreed, to act as president for the coming year.

The meeting was one of the most successful in the history of the Association, and warm thanks were conveyed to the Vice-Chancellor and all other members of the University who had done so much to make the visit a memorable one. Congratulations were also offered to the University on its recent jubilee celebrations.

Automatic Telephony and Teletyping.[1]

IT may be doubted whether the present generation works harder than the last, but, at any rate, it works at a much higher speed, and all kinds of devices are used to accelerate its rate of working. Whether this movement is altogether for the ultimate benefit of the human race is a moot question, but that it exists every one knows who has had experience of modern business methods. The incentive is the increase of profits that comes from doing an increased volume of work in a given time, by the aid of machinery. Speed and haste have very different meanings, and if the quality of the work does not suffer by the higher rate at which it is done, then the increase is beneficial, especially when it increases the time of the worker for exercise and recreation.

Amongst the devices for speeding up business, automatic telephony and printing telegraphy, or teletyping, will play a prominent part in the future. It is perhaps not generally known that the work of converting the manually operated telephone system of London into an automatic switching system has already been started. The task is a stupendous one, and it will take fifteen years to complete.

The accuracy of the service given in any telephone exchange, whether manual or automatic, depends largely on the ability of subscribers to use the telephone properly. The delays that occur at present are often due to a lack of clearness in articulating both the name of the exchange and the number, and to the congestion of traffic during the "busy hour." In an automatic, or, as the Americans more properly call it, a machine switching exchange, these difficulties do not arise, and if we make the probable assumption that a well-looked-after machine is more accurate than a human being, it seems certain that the machine switching system will give a better service than the manually operated system we have at present.

During the progress of conversion a called subscriber will often be connected with a manually operated exchange. The calling subscriber operates his instrument in the usual way, and the call passes to an operator at the manual exchange. Fitted to the panel in front of this operator is a group of forty lamps divided into four sections of ten lamps each,

[1] From the Presidential Address to the Junior Institution of Engineers, delivered by Dr. Alexander Russell on Wednesday, January 7.

and each section is numbered from 1 to 10. When the number dialled by the calling subscriber is received by this apparatus, four lamps glow, one in each section, and the operator sees at a glance the number of the subscriber required. The calling subscriber does not speak, and the connexion is made with the same ease as if it were all automatic.

When two subscribers attempt to call another at the same time, one gets through and the other hears the engaged signal. But when a call is made through a manual exchange, and the operator finds the required line is engaged, the call is stored until the line is clear.

One great advantage of the machine switching system is that the service will be as good in the night time as during the day. Except for, possibly, one or two short periods at the rush hours, the highest grade of service will be given. Errors due to faulty articulation will be a thing of the past. It has to be remembered that the system adopted by the British Post Office is one that is capable of being continually improved. Although the mechanisms remain the same, the rapid expansion of the system may lead to changes in the methods of operation in the immediate future.

These great auto-exchanges, with thousands of movable contacts in continual operation, appear uncanny to the non-technical person, but telephone engineers regard them in the same way as we would look on a large indicator for electric bells. Seeing that there are now more than twenty million telephone exchange stations in the world, it is instructive to remember that the first was built less than fifty years ago. We can be quite certain that the next fifty years will show an equally marvellous progress.

Wonderful though automatic telephony is, electricians believe that in a few years' time it will have an equally wonderful rival in the new printing telegraphy. The "ticker" is well known in large business offices where the latest quotations are printed in a continuous stream on a strip of paper. The latest information is thus always available and can be acted on immediately. In the United States both the Western Union and the Bell Telephone Companies will shortly offer telegraph typewriter service to business men, and it seems highly probable that this will be a commercial success. It will lead to teletype telegraphy, in which automatic switching exchanges not unlike those used in automatic telephony are employed.

It is perfectly feasible with this system for an ordinary girl typist to send messages up to 5000 miles at a speed of at least 30 words a minute. The British Post Office has already teletypes in use on several long lines. As the method extends, machine switching stations will become a necessity and are certain to be employed. It looks as if, in a few years' time, every wealthy person will have a "ticker" line for news superposed on his telephone line, his radio set being reserved mainly for entertainment purposes.

At first sight it might be thought that an air mail service would be a great rival to teletype telegraphy, but this is not the case. The actual time of a letter by air mail to Paris is about four hours. It takes about 40 minutes to get from Charing Cross to Croydon Aerodrome. From Croydon to the Paris Aerodrome takes about 2½ hours; and from the aerodrome in Paris to the city another 30 minutes. Finally, we have to allow at least 20 minutes for posting and delivery. It would generally, therefore, take more than four hours. By the new telegraphy a long printed telegram could be received in 10 minutes. For distances greater than 50 miles the new printing telegraphy would probably be better than telephony.

A serious drawback to the use at present of teletyping is the cost of a cheap printer and of a trustworthy typewriter keyboard, but in a few years' time, it is possible that there may be such a demand for hundreds of thousands of them as would make them very considerably cheaper; they might then cost little more than an ordinary good quality typewriter. There would be a local rate for payment and, doubtless, also a time and distance rate.

University and Educational Intelligence.

LONDON.—A number of free public lectures have been arranged for the coming term. Among them are the following, the number of lectures in the case of a course being indicated in brackets, and the lecture hour being 5.30 unless otherwise stated:—

At University College.—Series of eight lectures beginning on January 27: Prof. G. Elliot Smith, on the evolution of man; Mr. W. J. Perry, on the beginnings of civilisation, and on the spread of culture; Dr. C. F. Sonntag, on man's place in Nature (2); Prof. J. E. G. de Montmorency, on the significance of the humanism of the negro races; Mr. Reginald A. Smith, on the Old Stone Age, and Mr. C. D. Forde, on the megalithic monuments of Brittany; Dr. A. S. Parkes, on the physiology of reproduction (6), beginning January 22 at 5 P.M.; Prof. A. V. Hill, on the physiology of muscle and nerve (12), beginning January 23, at 11 A.M.; Prof. T. B. Wood, on the nutrition of the young animal (3), beginning March 4; Prof. A. C. Seward, on a botanical topic (3), commencing March 17; Prof. H. Westergaard, University of Copenhagen, on vital statistics (2), commencing March 9; Mr. A. Gomme, on technical and scientific libraries, on February 18 (one of a series of five lectures on the use of libraries).

At King's College.—Dr. J. A. Hewitt, on carbohydrate metabolism (8), beginning January 19 at 5 P.M.; Prof. E. V. Appleton, on the rôle of the atmosphere in wireless telegraphy, on January 19; Mr. C. J. Gadd, on the excavations at Ur, on January 26; Mr. S. Smith, on the nature and influence of Babylonian literature, on February 9; series of three lectures on Chinese civilisation: Lieut.-Commdr. A. S. Elwell Sutton, general views (February 5); Prof. W. E. Soothill, China's contribution to Western civilisation (February 12); Dr. I. P. Bruce, education in China (February 19); Prof. A. E. Jolliffe, on English mathematics before Newton, on February 16; Prof. E. Prestage, on Vasco Da Gama and the discovery of the sea-route to India, on February 13; Prof. E. W. Scripture, experimental investigations of German poetry, on February 26.

At the Royal School of Mines, S. Kensington.—Prof. L. Denoël, University of Liège, on tubbing deep shafts and subsidence (4), beginning February 23; Prof. C. A. Edwards, on chemical combination in metallic alloys and its nature (4), beginning March 3.

St. Bartholomew's Hospital Medical College.—Prof. C. Lovatt Evans, on the physiology of plain muscle (4), which began on January 14.

APPLICATIONS are invited for the professorship of botany in the West of Scotland Agricultural College, 6 Blythswood Square, Glasgow, in succession to the late Prof. A. N. McAlpine. The latest date for the receipt of applications is February 15.

ADULT education has been provided for in the United States on a rapidly increasing scale since the War. This is due to several causes, one being anxiety on the part of the State universities to give through their extension divisions conspicuous evidence of their usefulness, another the emergence of an insistent demand "that those who live in America must understand America." In Bulletins, 1923, Nos. 30 and 31, of the United States Bureau of Education, detailed accounts are given of measures recently taken for the Americanisation of adult immigrants, especially in California. It had become apparent that the very efficiency of the education given to their children in the common schools was undermining the control of the immigrant parents and disrupting their family life. "Under the roof of every immigrant home is going on a death struggle between two worlds, two cultures, two civilizations,—in the same family circle different tongues are spoken, different newspapers and books are read, different manners and customs observed, . . . a delicate network of precious traditions is (so it seems to the immigrant) being ruthlessly torn asunder, a whole world of ideals is crashing to ruin, and amid this desolation the father and mother picture themselves wandering about lonely in vain search of their lost children." To meet this situation, the State of California has provided for the employment of "home teachers" to work in the homes of the pupils of the common schools, giving instruction in sanitation, the English language, home economics, and the fundamental principles of the American system of government and the rights and duties of citizenship. It is clear from the report that these teachers, where carefully chosen, are doing extremely valuable work—such work, moreover, as is perhaps needed quite as much in other countries, including Great Britain, where aliens are numerous.

THERE is a marked contrast in the system of government, *i.e.* in the localisation of administrative power, between the universities of Australia and those of Great Britain and the United States. In the United States, the president, and in the British Isles the vice-chancellor (or principal), is the controlling and unifying force. The constitution of the University of Sydney provides that the Senate of 24 members, of whom not necessarily more than 5 need be members of the teaching staff, has the entire management of and superintendence over its affairs. It has hitherto out of its own body, annually, elected a chancellor and a vice-chancellor, the latter usually being a lawyer. Melbourne is governed by a Council of not more than 31 members, of whom less than one-third can be and less than one-quarter must be members of the teaching staff. The Professorial Board may forward to Council an opinion on any matter relating to the University, as may also Convocation, which consists of all graduates, but neither the Professorial Board nor Convocation has executive functions. The Council elects, annually, a chancellor and a vice-chancellor. For some time past the teaching members of the Australian universities have felt the need of a permanent chief. Sydney had already taken a step in that direction by appointing a warden when the Conference of Australian Universities in 1920 adopted the following resolution in favour of the establishment of an executive office analogous to that of principal or vice-chancellor of a British university :—"That it is desirable, for more effective working, and consonant with the general character of Australian Universities, that the appointment of an officer of high status, who could adequately represent both the administrative and the educational aspects of the University before other Universities and the public generally, be seriously considered." The Senate of Sydney has recently given effect to this resolution by converting the vice-chancellorship into a stipendiary administrative office. To this office, Dr. M. W. MacCallum, professor of modern literature for the period 1887–1920 and since 1920 emeritus professor, has been appointed as the first incumbent. Dr. MacCallum will shortly arrive in England for the purpose of delivering lectures by invitation of the British Academy.

Early Science at the Royal Society.

January 17, 1677/8. Dr. King instanced, that a gentleman who was a patient of his, could, two or three miles off London, discover when he entered into the smoke of London. Upon this some discourse arose about the reason why some chimnies smoke, that is, do not convey the smoke from the fire up the funnel, but suffer it to spread into the room.

January 18, 1664/5. Sir Robert Moray produced a discourse concerning coffee, written by Dr. Goddard at the King's command. Mr. Boyle mentioned, that he had been informed that the much drinking of coffee produced the palsy. The Bishop of Exeter seconded him. Mr. Graunt affirmed that he knew two gentlemen, great drinkers of coffee, very paralytical. Dr. Whistler suggested that it might be inquired whether the same persons took much tobacco.

1671/2. Mr. Newton's new telescope was examined and applauded.

January 20, 1663/4. The general and particular warrant to demand bodies for dissection, drawn up by Sir Anthony Morgan, was read and approved. [The president afterwards stated that a warrant had been issued for demanding a body for dissection, which was to be performed the day after the execution, in Gresham College, by Dr. Charleton, who had offered himself to open the muscles after a new method.]

1669/70. Mr. Hooke produced for examination two ways of making an universal measure. Many exceptions were made by divers members against both these ways. For these and like difficulties both these ways were laid aside.

January 21, 1662/3. Dr. Merret acquainted the society that he had received an information from Naples, concerning a person, who had an art of keeping new-born infants alive without respiration, for a good while. It was thought very desirable to have farther inquiry made.

1674/5. Sir John Bankes made a full report concerning the three fee-farm rents payable from fewes; concerning which the council accepted of the proposal, and resolved to dispose of the four hundred pounds legacy of the late Dr. Wilkins, bishop of Chester, for purchasing of them ; and accordingly desired Mr. Hoskyns to take care of a legal conveyance of the same to the Royal Society and their successors. —Mr. Oldenburg mentioned, that the earl of Aylesbury being obliged to go out of town, could not take care of providing a lecture, as he thought to have done, and had therefore sent to him his forty shillings ; which money was delivered to the treasurer.

January 22, 1661/2. The experiment of making marbled paper was made by a man introduced by the amanuensis ; which succeeded according to Mr. Evelyn's description of that method.—The pendulum experiment was discoursed of by the lord viscount Brouncker, who brought in the account and schemes of it. His lordship's paper was ordered to be registered, and a copy of it made against the Friday following, and brought to Sir Robert Moray, to be sent to Mons. Huygens.

1673/4. Mr. Lister having formerly sent some of his blood-stanching liquor, with a desire, that trials might be made with it before the Society, it was ordered, that the operator should provide a dog against the next meeting for that purpose.

January 23, 1666/7. Mr. Hooke was ordered to bring in something in writing relating to the controversy between Mr. Hevelius and Mons. Auzout, which might impart, that upon examination of the observations made in England, and compared with those in other parts, the society was inclined to believe, that Mr. Hevelius had been mistaken.

Societies and Academies.

LONDON.

Linnean Society, December 18.—E. J. **Collins**: The physiological aspect of the incidence of late blight (*Phytophthora infestans*) of potatoes. So far as the foliage is concerned, that of the early varieties of potato and those most susceptible to blight have the highest water content; the most resistant, which are the latest to mature, have the lowest water content. High water content induces rapid tuberisation, and this entails early maturation and susceptibility to blight. The nitrogen content of the foliage reaches a maximum and then falls more or less rapidly according to the growth period of the variety. Maturation is thus accompanied by a decreasing nitrogen content of the foliage. The water : nitrogen ratio increases during the season and in general is highest at the time of infection. The degree of susceptibility to blight is indicated more precisely by the value of this ratio. Young foliage has a lower water and higher nitrogen content than foliage of a medium age, while in old foliage the reverse conditions hold. Sprayed foliage shows a lower water and a higher nitrogen content than unsprayed foliage. The value of spraying, apart from the action of the copper solution as a fungicide, lies in its physiological effect, since those metabolic changes accompanying old age, and heightening susceptibility, are delayed.—R. B. **Seymour Sewell**: A study of the Andaman sea-basin. The Andaman Sea appears, originally, to have been formed during the Eocene epoch as a comparatively shallow brackish-water estuary, into which all the main rivers of Burma flowed, by the simultaneous upheaval of parallel mountain-ranges. At the close of the Miocene period a second upheaval, volcanic in character, caused the appearance of a mountain-chain that is now represented by Narcondam Island, Barren Island, and Invisible Bank. The present deep basin is due to extensive subsidence, probably in post-Tertiary times. Continued subsidence, or subaerial erosion followed by a rise of sea-level led to the formation of various channels permitting the entry into the basin of a shallow-water fauna derived from both the Indian and Pacific Oceans, and of a deep-water fauna derived from the Bay of Bengal.

PARIS.

Academy of Sciences, December 8.—Paul Séjourné was elected a free academician in succession to the late Prince Bonaparte.—Pierre **Humbert**: The $V_{m,n}$ functions of Hermite with imaginary indices.—A. **Kovanko**: Suites of functions of class I. (Baire).—Stanislas **Millot**: Some problems of Laplace. A discussion of some problems in the theory of probability.—E. **Paloque**: A new instrument for the determination of time and of latitude. This instrument is based on the observation of the simultaneous passage of two stars in the same azimuth.—Jean **Chazy**: The arrival in the solar system of a foreign star.—Charles **Henry**: A formula of the theory of relativity.—Jean **Granier**: The absorption of electromagnetic waves by ice. For the temperatures and frequencies studied, a condenser of pure ice may be represented by an arrangement of two condensers in parallel, one with an inductive capacity equal to 2·05, the other with an inductive capacity of about 78, the latter being in series with a resistance the value of which decreases as the temperature increases.—Félix-Joachim de **Wisniewski**: The doublets of the alkali metals.—P. **Job**: The electrometric study of hydrolysis.—A. **Boutaric** and G. **Corbet**: The critical temperature of solution of ternary mixtures. Curves are given showing the relation between critical solution temperatures of various ternary mixtures and their composition.—Jean **Thibaud**: The penetrating γ-radiation of mesothorium-2.—L. J. **Simon** and A. J. A. **Guillaumin**. Some derivatives of tetracetylmucic acid.—Léon **Piaux**: The spontaneous oxidation in alkaline solution of 1-methyluric and 1·3-methyluric acids. On oxidation in alkaline solution, 1-methyluric acid behaves similarly to uric acid, but 1·3-dimethyluric acid is completely split up, giving methylamine, potassium oxalurate and oxalate.—Georges **Patart**: The synthesis of methyl alcohol by reduction of carbon monoxide. A mixture of carbon monoxide (1 vol.) and hydrogen (1·5 to 2 vol.), under a pressure of 156 to 250 atmospheres, is circulated over a catalyst (zinc oxide) at a temperature between 400° and 420° C. On cooling to 20° C., a liquid is obtained containing water and methyl alcohol, with traces of impurities. Neither aldehyde nor acetone is present in this alcohol. The author considers that the commercial preparation of synthetic methyl alcohol by this method offers no serious difficulties.—Henri **Hubert**: Contribution to the study of the microseismic disturbances at Dakar (Senegal). The small earth vibrations at Dakar would appear to be mainly due to the impact of waves of the sea at points near this locality.—Ch. **Maurain**: The propagation of aerial waves as shown by the experiments at La Courtine. Two maps are given showing areas in which the velocity of propagation of the waves was that of the velocity of sound, and other areas in which the velocity was much lower than the velocity of sound: the latter are called zones of abnormal reception.—E. **Delcambre**: The meteorological work of the Jacques-Cartier service.—Ch. **Kilian** and R. G. **Werner**: Pure cultures of the fungi of lichens.—Mme. L. **Randoin**, J. **Alquier**, Mlles. **Asselin** and **Charles**: The nitrogenous materials of wheat offal. Comparative study of their biological value as factors of upkeep, of growth and of reproduction. Wheat offals (bran, etc.) regarded as a source of nitrogen have not the same biological value in a normal ration.—M. and Mme. G. **Villedieu**: The action of solutions of copper sulphate on mildew. Millardet in 1886 pointed out the toxic action of very dilute solutions (1 in 4,000,000) of copper sulphate on the mildew of the vine (*Plasmopara viticola*). The authors show that the copper sulphate was not really in solution, but was present as very fine flocculated precipitates of basic copper sulphate, removable by filtration. The toxic action is exerted by this insoluble basic copper sulphate.—A. **Malaquin**: The genital glands and primordial sexual cells in the annelid *Salmacina Dysteri*.—J. **Legendre**: Zoophilia in mosquitoes and its application to prophylaxy.—A. **Paillot**: A new disease of the caterpillars of *Pieris Brassicae*, and on diseases of the nucleus (of the blood corpuscles) in insects.—Ch. **Dhéré**, A. **Schneider** and Th. van der **Bom**: The fluorescence of some metallic compounds of hæmatoporphyrin. Details of the photographed fluorescence spectra of the compounds of hæmatoporphyrin with zinc, tin, lead and cadmium.—Albert **Dalcq**: A new method of experimental parthenogenesis and its application. The maturation, activation and segmentation of the egg of *Asterias glacialis* can be produced by a single solution: the segmentation of the virgin egg is the result of the specific effects of various cations.—C. **Dawydoff**: Reduction in *Lineus lacteus*.

CALCUTTA.

Asiatic Society of Bengal, November 5.—S. H. **Lele**: Studies on Bombay fish. Revision of the genus Drepane (Cuv. and Val.). The anatomical and morphological characters of the members of the genus Drepane are discussed. In view of constant differences, the genus should be split up into two species, as was done by Cuvier and Valencinnes.—B. P. **Uvarow**: Orthoptera (except Blattidæ) collected by Prof. Gregory's expedition to Yunnan. An account is given of the Yunnanese crickets and their allies collected by Prof. Gregory. The fauna of the Yunnanese mountains is found to be palæarctic while that of the valleys is truly oriental.—R. **Hanitsch**: Blattidæ collected by Prof. Gregory's expedition to Yunnan. Three species were found in Prof. Gregory's collection, two of which are described as new to science.—H. **Hosten**: (1) Zādoē, of St. Thomas' Monastery in India (about A.D. 363). A short supplementary note to the author's recent study on St. Thomas and San Thomé, Mylapore, in the Society's Journal, quoting a reference to St. Thomas purporting to go back to the fourth century A.D. (2) A letter of Fr. A. de Andrada, S.J. (Tibet, August 29, 1627), and of Fr. Gaspar Diaz, S.J. (Annam, 1627). Spanish texts, with English translations, and notes. The letter by Diaz was published together with the other, probably in 1629, in two folio leaves, and a copy of the publication is in the British Museum. De Andrada's letter is not known in its original Portuguese form. Both give additional data concerning early European contact with Tibet and Further India. (3) A letter of Father Francisco Godinho, S.J., from Western Tibet (Tsaparang, August 16, 1626). This original French text adds to the data recently made available concerning early contact with Tibet through the efforts of the Roman Catholic missionaries in the beginning of the seventeenth century.—A. S. Ramanatha **Ayyar**: A note on Arddhanārīśvara. The identification proposed by Father H. Hosten in his recent paper on St. Thomas in the Society's Journal is criticised. The figure there interpreted as the representation of an Amazon is in reality one of Arddhanārīśvara. The theory of Egyptian influence at Mahābalipuram in the seventh century A.D. is therefore rejected.—M. Hidayet **Hosain**: The development of the Hadīth concordance in Arabic literature. The traditional sayings attributed to the Prophet Muhammad form a body of literature ranking first in importance in Islamic theology after the study of the Quran itself. The number of these sayings is overwhelmingly great, and from early times Muslim theologians have felt the need for the classification of them, and for a system to refer them to their sources. The science of "locating" the traditions is called "'Ilm al-Atrāf," and the author traces the development of the literature expounding this science from A.H. 400 to the present day.—'Abdul **Walī**: Sketch of the life of Sarmad. Sa'id, surnamed Sarmad, a contemporary of Shah Jahan and Aurangzeb, was a Persian of Jewish birth. He came to India and after much wandering settled at Delhi. He was of a mystic temperament and embraced Islam, into which he introduced his mystic speculations. On a charge of heresy he was beheaded by order of Aurangzeb.

Official Publications Received.

Proceedings of the Eleventh Indian Science Congress (Bangalore, 1924). Pp. xv+262. (Calcutta: Asiatic Society of Bengal.) 6.12 rupees.

Journal of the College of Agriculture, Hokkaido Imperial University, Sapporo, Japan. Vol. 12, Part 2: Über den Einfluss meteorologischer Faktoren auf den Baumzuwachs (I). Uber den Einfluss auf den Stammumfang eines Tannenbaumes. Von Hirokichi Nakashima. Pp. 69-263+plates 13-26. (Sapporo.)

Public Health Administration and the Natural History of Disease in Baltimore, Maryland, 1797-1920. By Dr. William Travis Howard, Jr. (Publication No. 351.) Pp. vi+565+2 maps. (Washington: Carnegie Institution.) 3.25 dollars.

General and Physiological Features of the Vegetation of the more Arid Portions of Southern Africa, with Notes on Climatic Environment. By William Austin Cannon. (Publication No. 354.) Pp. viii+159+31 plates. (Washington: Carnegie Institution.) 2.50 dollars.

Root Behavior and Crop Yield under Irrigation. By Frank C. Jean and John E. Weaver. (Publication No. 357.) Pp. v+66+6 plates. (Washington: Carnegie Institution.) 1.25 dollars.

Department of Agriculture, Straits Settlements and Federated Malay States. Bulletin No. 36: "Red Stripe" Weevil of Coconuts (*Rhynchophorus schach*, Oliv.). By G. H. Corbett and D. Ponniah. Pp. 51+6 plates. (Kuala Lumpur.) 50 cents.

Department of Commerce: U.S. Coast and Geodetic Survey. Terrestrial Magnetism. Serial No. 268: Results of Magnetic Observations made by the United States Coast and Geodetic Survey in 1923. By Daniel L. Hazard. (Special Publication No. 102.) Pp. 44. (Washington: Government Printing Office.) 10 cents.

Proceedings of the Royal Society of Edinburgh, Session 1924-1925. Vol. 45, Part 1, No. 2: The Irreducible System of Concomitants of Two Double Binary (2,1) Forms. By W. Saddler. Pp. 3-13. Vol. 45, Part 1, No. 3: A Series Formula for the Roots of Algebraic and Transcendental Equations. By A. C. Aitken. Pp. 14-22. Vol. 45, Part 1, No. 4: The Electrolysis of Salts of Alkyloxyacids. By Dr. David A. Fairweather. Pp. 23-33. (Edinburgh: R. Grant and Son; London: Williams and Norgate, Ltd.) 1*s*. each.

Anuario del Observatorio de Madrid para 1925. Pp. 477. (Madrid: Instituto Geográfico.)

The Scientific Proceedings of the Royal Dublin Society. Vol. 17, N.S., Nos. 42-47, August. 42: Experiments on the possible Effect of Vitamins on Quantity of Milk and Butter Fat, by E. J. Sheehy; 43: A Mechanical Device for Sealing off Radium Emanation Tubes, by Dr. H. H. Poole; 44: Notes on the Filtration and other Errors in the Determination of the Hydrogen Ion Concentration of Soils, by Dr. W. R. G. Atkins; 45: Variations in the Permeability of Leaf-Cells, by Prof. Henry H. Dixon; 46: Notes on Acarine or Isle of Wight Bee Disease, by Lt.-Col. C. Samman and Prof. J. Brontë Gatenby; 47: Note on a Physical Method of separating the Fats in Butter-fat, by Prof. Felix E. Hackett and T. A. Crowley. Pp. 333-368. 4*s*. Vol. 18, N.S., Nos. 1-4, November. 1: Seasonal Changes in the Water and Heleoplankton of Fresh-water Ponds, by W. R. G. Atkins and G. T. Harris; 2: The Synthesis of Urea from Carbon Dioxide and Ammonia under Atmospheric Pressure (Part 1), by Dr. Kenneth C. Bailey; 3: Oogenesis in Lithobius forficatus, by S. D. King; 4: The Determination of the most Economic Size of Pipe-line for Water-power Installations, by H. H. Jeffcott. Pp. 48. 5*s*. (Dublin: Royal Dublin Society; London: Williams and Norgate, Ltd.).

Department of Commerce: Bureau of Standards. Miscellaneous Publications No. 58: Technical Conference of State Utility Commission Engineers, held at the Bureau of Standards, Washington, D.C., March 2 and 3, 1923. Pp. iii+80. (Washington: Government Printing Office.) 15 cents.

National Museum of Wales. Seventeenth Annual Report, 1923-24, presented by the Council to the Court of Governors on the 24th October 1924. Pp. 38+6 plates. (Cardiff.)

City of Leicester Museum and Art Gallery. Twentieth Report to the City Council, 1st April 1912 to 31st March 1924. Pp. 66. (Leicester.)

The National University of Ireland. Calendar for the Year 1924. Pp. viii+324+369+117. (Dublin.)

Annuaire pour l'an 1925, publié par le Bureau des Longitudes. Pp. viii+686+A71+B56+C71. (Paris: Gauthier-Villars et Cie.) 6.50 francs.

The Pleistocene of the Middle Region of North America and its Vertebrated Animals. By Oliver P. Hay. (Publication 322A.) Pp. vii+385. (Washington: Carnegie Institution.) 2.50 dollars.

City and County of Bristol: The Bristol Museum and Art Gallery. Report of the Museum and Art Gallery Committee, for the Year ending 30th September 1924. Pp. 20+8 plates. (Bristol.)

Ministry of the Interior, Egypt: Department of Public Health. Reports and Notes of the Public Health Laboratories, Cairo. Ankylostomiasis and Bilharziasis, Cairo. Pp. iii+196. (Cairo: Government Publications Office.) 30 P.T.

Diary of Societies.

SATURDAY, JANUARY 17.

PHYSIOLOGICAL SOCIETY (in Physiological Laboratory, St. Thomas's Hospital), at 4.—R. J. S. McDowall: The Sensory Sympathetic Nerves.—J. W. Pickering and H. Gordon Reeves: Thrombocytes and Blood Coagulation.—K. Furusawa: The Respiratory Quotient of the Excess Metabolism produced by Muscular Work.—A. St. G. Huggett and Prof. J. Mellanby: Preparation and Properties of Secretin.—L. N. Katz: The Asynchronism of the Contraction of the two Ventricles.—E. C. Smith: Insulin and Fat Metabolism.—R. Kinosita: Effect of Breathing against a Resistance.—J. Needham and Dorothy Needham: The pH and rH of the Cell-Interior—a Micro-Injection Study.—D. Burns: (1) The Inter-relation of the Parathyroids and the Gonads; (2) Guanidine in Urine.—Sybil Cooper: The Rate of Conduction in Nerve in the Supernormal Phase of Recovery.—C. D. Murray and H. Taylor: Method of Determination of the Oxygen and CO_2 in Mixed Venous Blood.

INSTITUTE OF BRITISH FOUNDRYMEN (Lancashire Branch, Junior Section) (at Manchester College of Technology), at 7.—J. G. Robinson: Moulding a large Fly-Wheel (Lecture).

MONDAY, JANUARY 19.

CAMBRIDGE PHILOSOPHICAL SOCIETY, at 4.30.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Dr. Dorothy M. Wrinch: Seismic Phenomena.

ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge), at 5.—C. S. Wright: The Origin and Movements of the Ross Barrier.
ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Recent Discoveries of Fossil Man (I). The Antiquity of Man in South Africa. The Boskop Skull. The Relationship of the Boskop Race to Bushmen and Hottentot.
INSTITUTION OF MECHANICAL ENGINEERS (Graduates' Section), at 7.—A. J. D. Humby: Turbo-Blowers.
JUNIOR INSTITUTION OF ENGINEERS (North-Western Section) (at 16 St. Mary's Parsonage, Manchester), at 7.15. — J. Prior: Confectionery Machinery.
INSTITUTION OF AUTOMOBILE ENGINEERS (Scottish Centre) (at Royal Technical College, Glasgow), at 7.30.—C. Macbeth: Low-Pressure Pneumatic Tyres.
INSTITUTION OF ELECTRICAL ENGINEERS (Mersey and North Wales (Liverpool) Centre) (at Liverpool University), at 7.30. — Sir Oliver Lodge (Lecture).
ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—Dr. O. Faber: Applications in Building and Foundations of Modern Engineering Construction.
ARISTOTELIAN SOCIETY (at University of London Club), at 8.—W. O. Brigstocke: Pickwickian Senses.
ROYAL SOCIETY OF ARTS, at 8.—V. E. Pullen: Radiological Research—a History (1). (Cantor Lectures.)

TUESDAY, JANUARY 20.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. A. Fowler: The Analysis of Spectra (II.).
ROYAL STATISTICAL SOCIETY (at Royal Society of Arts), at 5.15.
MINERALOGICAL SOCIETY (at Geological Society), at 5.30.—Miss K. Yardley: An X-ray Examination of Calcium Formate.—J. Parry and Dr. F. E. Wright: Afwillite, a New Hydrous Calcium Silicate from Dutoitspan Mine, Kimberley, South Africa.—Prof. P. N. Chirvinsky: On Tyuyammite from Tyuyu-Muyun Radium Mine, Fergana.—Dr. L. J. Spencer: International Agreement in Mineralogical and Crystallographical Nomenclature.
INSTITUTE OF MARINE ENGINEERS, at 6.30.—Eng.-Lt. A. Marsden: Oil Fuel Burning in Steam Generator and Furnace.
INSTITUTION OF ELECTRICAL ENGINEERS (East Midland Sub-Centre) (at Derby Technical College), at 6.45.—C. Beaver: Some Points in the Manufacture and Installation of High-Voltage Cables.
INSTITUTION OF ELECTRICAL ENGINEERS (North-Western Centre) (at Engineers' Club, Manchester), at 7.—H. W. Taylor: Three-Wire Direct-Current Distribution Networks.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Kinematograph Group), at 7. — Kinematograph Demonstration of some Experiments in Physics.
INSTITUTION OF AUTOMOBILE ENGINEERS (Wolverhampton Centre) (at Engineers' Club, Wolverhampton), at 7.30.—C. Macbeth: Low-Pressure Pneumatic Tyres.
INSTITUTION OF ELECTRICAL ENGINEERS (Scottish Centre) (Informal Meeting) (at 39 Elmbank Crescent, Glasgow), at 7.30.—Miss Kennedy: Electric Cooking.
MEDICO-LEGAL SOCIETY (at 11 Chandos Street, W.), at 8.30.—F. Ll. Jones: The Laws of Nations and the Health of Nations.

WEDNESDAY, JANUARY 21

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Recent Discoveries of Fossil Man (II.). The Rhodesian Skull. The Relationship of Rhodesian Man to Living and Extinct Types of Mankind.
GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Prof. Léon W. Collet: Recent Views on Alpine Tectonics.
RADIO SOCIETY OF GREAT BRITAIN (at Institution of Electrical Engineers), at 6.—Sir Oliver Lodge: Matter and Radiation (Presidential Address).
INSTITUTION OF AUTOMOBILE ENGINEERS (Graduates Meeting) (at Chamber of Commerce, Birmingham), at 7.30.—J. G. Sheriffs: Steering.
INSTITUTION OF ELECTRICAL ENGINEERS (Sheffield Sub-Centre) (at Royal Victoria Hotel, Sheffield), at 7.30.—W. E. Burnand: Inventions and Patents.
INSTITUTION OF PRODUCTION ENGINEERS (at Engineers' Club, Coventry Street, W.), at 7.30.—H. A. Randall: Instruments andGauges.
ROYAL METEOROLOGICAL SOCIETY (Annual General Meeting), at 7.40.—C. J. P. Cave: The Present Position of Meteorology and Meteorological Knowledge.
ROYAL MICROSCOPICAL SOCIETY (Annual Meeting), at 7.45.—A. Chaston Chapman: The Yeasts: a Chapter in Microscopical Science (Presidential Address).
ROYAL SOCIETY OF ARTS, at 8.—Mrs. Graydon-Stannus: Irish Glass, Old and New.
SOCIETY OF GLASS TECHNOLOGY (at Birmingham).

THURSDAY, JANUARY 22.

ROYAL SOCIETY, at 4.30.—Prof. H. C. H. Carpenter and Miss C. F. Elam: Experiments on the Distortion of Single-Crystal Test Pieces of Aluminium.—J. V. Howard and S. L. Smith: Recent Developments in Tensile Testing.—R. L. Smith-Rose and R. H. Barfield: On the Determination of the Directions of the Forces in Wireless Waves at the Earth's Surface.—*Papers to be read in title only*:—Prof. D'Arcy Thompson: On the Thirteen Semi-regular Solids of Archimedes, and on their Development by the Transformation of Certain Plane Configurations.—W. S. Farren and Prof. G. I. Taylor: The Heat developed during Plastic Extension of Metals.—U. R. Evans: The Colours due to Thin Films on Metals.—A. Campbell: On the Determination of Resistance in Terms of Mutual Inductance.—S. Butterworth: On the Alternating Current Resistance of Solenoidal Coils.
LINNEAN SOCIETY OF LONDON, at 5.—The President and R. D'O. Good: The Recent Meeting in Canada of the British Association.
ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—J. S. Huxley: The Courtship of Animals and its Biological Bearings (II.).
ROYAL AERONAUTICAL SOCIETY, at 5.30.—Major R. V. Southwell: Some Recent Work of the Aerodynamics Department, National Physical Laboratory.
INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—H. W. Clothier: The Design of Electrical Plant, Control Gear and Connexions for Protection against Shock, Fire and Faults.
INSTITUTION OF AUTOMOBILE ENGINEERS (Luton Graduates Meeting) (at Luton), at 7.30.—A. C. Saward: Carburation.
INSTITUTE OF CHEMISTRY (Edinburgh and East of Scotland Section) (and Society of Chemical Industry, Edinburgh and East of Scotland Section) (at North British Station Hotel, Edinburgh), at 7.30.—Prof. J. Hendrick: The Alsatian Potash Mines.

FRIDAY, JANUARY 23.

ROYAL DUBLIN SOCIETY, at 4.30.
PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 5.—Dr. B. W. Clack: An Investigation of the Measurement of Small Differences of Refractive Index by the Rayleigh Interferometer.—J. Taylor and W. Clarkson: A Study of the Production of Flashing in Air Electric Discharge Tubes.—C. R. Darling: A Kinematographic Study of Plateau's Spherule (Demonstration).
ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Recent Discoveries of Fossil Man (III.). Recent Discoveries in Australia and Java and their Bearing on the Theory of Man's Evolution.
INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Reports to the Cutting Tools Research Committee.—Dr. W. Rosenhain and A. C. Sturney: Flow and Rupture of Metals during Cutting.—Dr. T. E. Stanton and J. H. Hyde: An Experimental Study of the Forces exerted on the Surface of a Cutting Tool.
THE SOCIETY OF DYERS AND COLOURISTS (London Section) (at Australia House, Strand), at 7.—J. Craft: Incorporation of Eulan into Woollen Textiles and other Fabrics, Permanent Protection against Moth Damage (Lecture).
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—Lantern Lecture.
JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—R. H. Parsons: Boiler-house Records and their Practical Value (Lecturette).
NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at Literary and Philosophical Society, Newcastle-upon-Tyne), at 7.30.—E. A. Eborall: Railway Electrification in Switzerland (Lecture).
NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Middlesbrough Graduate Section) (at Cleveland Scientific and Technical Institution, Middlesbrough), at 7.30.—T. Lewis: Gas Producers.
C.B.C. SOCIETY FOR CONSTRUCTIVE BIRTH CONTROL AND RACIAL PROGRESS (at Essex Hall, Essex Street, W.C.), at 8.—Prof. A. M. Carr-Saunders: The History of the Limitation of Numbers.
ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Dr. A. W. Crossley: Science and the Cotton Industry.

PUBLIC LECTURES.

MONDAY, JANUARY 19.

KING'S COLLEGE, at 5.—Dr. J. A. Hewitt: Carbohydrate Metabolism (Succeeding Lectures on January 26, February 2, 9, 16, 23, March 2, 9.)
LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE, at 5.—Dr. E. B. Behrens: International Problems of Industry (I.). Historical Background, and the Competitive Element in the Determination of Conditions of Labour.
UNIVERSITY COLLEGE, at 5. — Prof. G. Elliot Smith: The Lectures on the Anatomy and Physiology of the Sympathetic Innervation of the Striated Muscle, prepared for delivery by the late Prof. J. I. Hunter. (Succeeding Lectures on January 26 and February 2.)
KING'S COLLEGE, at 5.30.—Prof. E. V. Appleton: The Rôle of the Atmosphere in Wireless Telegraphy.

TUESDAY, JANUARY 20.

UNIVERSITY OF LEEDS AND LEEDS PHILOSOPHICAL AND LITERARY SOCIETY (at Leeds University), at 8. — Prof. A. Gilligan: The Geology of Yorkshire: Cleveland and the Yorkshire Wolds.

WEDNESDAY, JANUARY 21.

LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE, at 5.—W. H. Ansell: The Principles of Design as applied to Buildings.
KING'S COLLEGE, at 5.30.—M. L. W. Laistner: The Decay of Geographical Knowledge and the Decline of Exploration, A.D. 300-500.
UNIVERSITY COLLEGE, at 5.30.—H. Jenkinson: The Public Record Office and Archives.

THURSDAY, JANUARY 22.

UNIVERSITY COLLEGE, at 5.—Dr. A. S. Parkes: The Physiology of Reproduction. (Succeeding Lectures on January 29, February 5, 12, 19, 26.)

FRIDAY, JANUARY 23.

UNIVERSITY COLLEGE, at 11 A.M.—Prof. A. V. Hill: The Physiology of Muscle and Nerve. (Succeeding Lectures on January 30, February 6, 13, 20, 27, March 6, 13, 20, 27, April 3, 10.)
UNIVERSITY OF LEEDS AND LEEDS PHILOSOPHICAL AND LITERARY SOCIETY (at Philosophical Hall, Leeds), at 8.—Prof. D. M. S. Watson: The Origin of Land Vertebrates.

SATURDAY, JANUARY 24.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—W. J. Perry: Rough Stone Monuments and their Builders.