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Coal Utilisation and Research.

THE Report of the Royal Commission on the Coal Industry, some aspects of which were presented by Prof. Henry Louis in an article in NATURE of March 20, is still under consideration and discussion. It is now generally understood that the report refuses to prescribe for the sick man any tonic or pill with the pleasing promise of a lightning cure, but insists on the necessity for a systematic application of the principles of economic hygiene to daily life as the primary essential to recovery. Even such labels as low-temperature carbonisation and electrification on the medicine bottles are not held to guarantee a cure. It is not that the spirit of the Commission has been cautious, conservative, or narrow. Its report is, indeed, quite remarkable for breadth of view, and for what appears to be a well-balanced consideration of the very numerous and varied factors which are operative in the problem presented. These characteristics can certainly be claimed for Chaps. iii. and iv. on utilisation of coal, and research, with which the present writer is more immediately concerned.

The position as regards actual and potential methods of consuming coal is admirably stated in Chap. iii., while Chap. iv. deals with the existing provision for research connected with coal, particularly 'organised' research, and with proposals for extending that provision. Under pre-treatment of coal, the adoption in the eighteenth century by British ironmasters of the use of coke in their blast furnaces is given the first place, initiating an industry which now employs 40,000,000*l.* of capital, and yields not only coke, but also tar, sulphate, benzole, and surplus gas. The position of the parallel carbonisation process, that of the gasworks, is indicated by the statement that the capital now engaged in it is 160,000,000*l.*—not very far short of the capital of the mining industry itself. Yet these two industries, in which coal is systematically treated before use, represent only some 37 million tons, while the coal consumed in its raw state amounts to 147 million tons, and the statement is made that, while for some purposes, such as large boiler plants, it is doubtful whether it would be economical to carbonise the coal before burning it, there is no doubt that a large proportion of the 147 million tons is consumed in a very wasteful manner.

The consideration of pollution of the atmosphere by smoke, the possibility of supplying oil from coal, and the position of low-temperature carbonisation, follow naturally with some reference to the use of pulverised solid fuel for firing furnaces and of the so-called colloidal fuel, that is, finely divided coal mixed with fuel oil. There is probably no one remedy for the smoke nuisance

which would compare in importance with the use of some form of smokeless solid fuel in the domestic grate, and the interest in low-temperature carbonisation is stimulated by that idea. But the pronouncement of the Commission based upon a memorandum furnished by Dr. Lander is inevitably very guarded:

"We have given close attention to the question of low-temperature carbonisation, but we can find no evidence that the system has yet been anywhere established on a commercial scale for a period sufficiently long to enable the claims that are made on its behalf to be fully tested."

It is not that carbonisation at a low temperature is a technically unrealisable process, since it is in essence a reversion to older practice. The difficulties are quantitative and commercial, and the problem is to overcome those difficulties in a fashion quite opposite to that adopted by the gas industry, which has developed by carbonising at high temperature and obtaining the maximum possible yield of gas—the carbonisation product which displays a greatly enhanced thermal efficiency in use with a correspondingly increased monetary value. Research on this subject is likely to have to go far back into the properties of coal itself, and the possible means of utilising and modifying such properties so as to arrive at a cheap and rapid process which will give the results required without incurring excessive costs in the installation of plant, and the working of the process itself. Encouragement is forthcoming from demands of different origin, since apart from all question of smoke abatement there is the national need for home supplies of liquid fuel, including motor spirit, and the desirability of finding some sort of use for low-grade coals, at present of no commercial value. If it were possible to subject to this process the bulk of the 147 million tons of coal now consumed in the raw state, the greater part at least of present British requirements of oil could be supplied from home sources, instead of being imported from abroad. Nor is the Commission pessimistic.

". . . the evidence we have taken has given us the impression that we may be within measurable distance of a solution of both the technical and commercial problems that arise. We recommend that the Government should give sympathetic consideration to any proposals of the Fuel Research Board for the further investigation of the process on a commercial scale."

There is no doubt that here a great difficulty presents itself. So far as concerns the scientific and technical research to which reference has been made above, into the properties of coal itself, the path is comparatively smooth, but the solution of what are grouped under the term of 'Commercial problems' is another matter. The Fuel Research Board has already gone so far as to undertake, without charge, the testing-out of low-temperature carbonisation plants on a commercial scale in order to obtain reliable information and to give it to those concerned. This is, as the writer can say from experience, no easy matter to carry through in such a way as to obtain trustworthy results, but it is practicable. The commercial interpretation of such results in a form to have any general application is, however, much more difficult, and the Fuel Research Board has so far held its hand at that stage. If, too, the financial backing of pioneering industrial adventures in this field is to be undertaken, it will have to be with eyes open to the very large costs which are only too easily incurred in such work without tangible results.

The Commission lays great stress on the co-ordination of coal-using industries, and its report should go far to counteract the mistaken ideas only too easily derived from the ill-balanced report of the Coal Conservation Committee issued in 1918. The Commission says:

"It has been strongly impressed upon us as the outcome of our enquiries that it is an error to suppose that the only, or even the principal, object to be aimed at in this connexion is the most economical method of producing electricity. The object to be aimed at is the most economical and efficient way of utilising the energy embodied in the coal. The question is not co-ordination, as is often supposed, of two industries—coal and electricity—but of several—coal, electricity, gas, oil, chemical products, blast furnaces, coke ovens, etc. Two or more methods, dealing with two, three, or more of these, would be used simultaneously in combination, one feeding the other. The point of importance is, that no obstacles, whether of State regulation or industrial organisation, should be placed in the way of the development of such combinations in whatever manner engineering and chemical skill and the economic conditions may indicate as the most suitable."

Arising out of such considerations, the Commission "venture to suggest for consideration the formation of a Standing Conference composed perhaps of the Chairman and other representatives of those bodies we have mentioned," these being the Coal Commissioners (whose appointment is recommended elsewhere), the National Gas Council, and the Electricity Commissioners. Its primary task would be to ensure that while a healthy competition should be maintained where it was legitimate between these various interests, their energies should be developed in a manner complementary in the main to each other. Moreover, it is proposed that a survey, which from the nature of the case should be a continuous process undertaken by a body of a permanent character, should be made of the heat, light, and power requirements of the various industries of the country as a whole.

The Commission has concerned itself seriously with research into matters connected with coal as of primary

importance, reviewing the present provision and suggesting developments. In all such schemes one outstanding point is often overlooked. If an industry is to reap the full value of research work done within it or on its behalf, it is essential that in the executive ranks of the industry itself, in its direction and management, there should be men willing and able to give effect to the results obtained and discoveries made. For this reason, the conversion of an industry from the empirical to the scientific is a gradual process, and is not to be done simply by the attachment of a research staff (with the formulation of a programme) to an industry which remains at heart unconvinced of the value of scientific work. The following sentence in the report is no doubt inspired by some such conviction: "It is also essential that the industry as a whole should become imbued with the spirit of science in order that it may utilise to the fullest extent the results of modern scientific developments." Another point of importance recognised is that the existing supply of research workers for the fuel industry is quite inadequate to meet such demands as are contemplated, and the recommendation is made "that the Colliery Owners' Research Association encourage the scientific training of students for the work of the Research Association, and for the survey, and that for these purposes it be authorised to provide scholarships and arrange with universities for suitable courses."

The field of research surveyed is a large one, including as it does occurrence and constitution of coal, coal winning, and coal utilisation, each with its subdivisions, hygiene and safety being given prominence in the coal-winning section. Work already in hand by the Fuel Research Board, the Safety in Mines Research Board, the Geological Survey, the Colliery Owners' Research Association, and the National Federation of Iron and Steel Manufacturers, is described, as also that carried out in conjunction with the University of Leeds by the Gas Investigation Committee of the Institution of Gas Engineers and by the National Benzole Association. It is noted that the Bergius process for the 'liquefaction' of coal and synthetic methods for the conversion of water-gas mixed with additional hydrogen into motor-spirit are receiving attention.

Then comes a section on the future of research work, which begins with an expression of opinion that the attitude of the British Coal Owners' Research Association (as indicated by Mr. Evan Williams, President of the Mining Association, in evidence) "indicates an insufficient appreciation of the importance of this question," and further emphatic statements, such as, "While research alone will not overcome the difficulties from which the Industry is now suffering [a qualification which the writer is glad to see made] we feel strongly that the steady and continuous investigation into all pertinent problems is essential if the industry is to prosper and to provide good wages and conditions for its workers."

Recommendation is made that the British Colliery Owners' Research Association be rapidly expanded, and that the managing council of the Association should be composed of representatives of the owners, managers, mining engineers, workers in the industry, the Mines Department, and the Department of Scientific and Industrial Research. A sum of 100,000*l.* should be provided for the establishment of a headquarters, a highly qualified director of research appointed, and such continuity as will attract the right men for the staff and render possible the obtaining of useful results in work which is necessarily slow, should be secured by guaranteeing an income averaging 40,000-50,000*l.* per annum for at least seven years. The funds are to be provided partly by the owners and partly by the Department of Scientific and Industrial Research, which is to take the initiative in organising and developing the Research Association. According to this scheme there would then be three large organisations, each dealing with one aspect of the coal problem: (*a*) The Colliery Owners' Research Association, expanded as indicated above, (*b*) The Safety in Mines Research Board, and (*c*) The Fuel Research Division of the Department of Scientific and Industrial Research. Co-ordination of the work is to be effected by the Department of Scientific and Industrial Research.

Such are the recommendations on research made by the Commission, and they have no doubt been carefully considered. It is plain that they place the Department of Scientific and Industrial Research in a highly responsible position at the centre of a highly elaborated organisation for dealing with a subject, that of research, which from its very nature is particularly difficult to organise. The maintaining together of sufficient elasticity in administration, insight and efficiency in the various directing bodies and their staffs, and goodwill in all concerned, will call for a very exceptional power of co-ordinating these estimable but not all-pervading qualities. The research programme is, however, so comprehensive as to give large scope for choice and initiative in its translation into active research, and even a fractional fulfilment of its promise would be a great national benefit. One note of warning may be sounded. If those engaged in the coal industry begin to make the assumption that research and pioneering work are essentially the concern of the nation or some association, and no longer that of the firm or the individual, many of the paths of progress, and quite probably the best, will be left unexplored.

JOHN W. COBB.

The Science of the Humanities.

A Dictionary of European Literature: Designed as a Companion to English Studies. By Laurie Magnus. Pp. xii+594. (London: George Routledge and Sons, Ltd.; New York: E. P. Dutton and Co., 1926.) 25*s.* net.

"BEAUTY is Truth, Truth Beauty," wrote Keats, in passionate protest against all attempts to divorce them or to see in one the antipathy of the other. A similar recognition is growing that the oft-assumed antithesis between literature and science is a wanton and needless invention. The humanities of science has yet to be written, perhaps, though odd chapters have appeared from time to time; but the science of the humanities, if by such a phrase we may indicate the scientific treatment, in the widest sense of the word 'science,' of the material of the humanities, has for some time had its expositors.

The volume before us is a notable example of this larger view. It is, we believe, the first attempt yet made to apply, on such a restricted scale as the single volume, the comparative method to the literature of Europe. Prof. Saintsbury in his "Periods of European Literature" divided the subject into twelve "Periods" and marshalled a dozen specialists for the work, each of whom wrote a history of his chosen and allotted period. But if English studies are to be made as valuable a discipline as the Greek and Latin which they are displacing in the upper forms of the public schools and in the universities, there is need of a reference book covering the whole field in a single volume. Smith's "Dictionary of the Bible" and Lempriere's "Classical Dictionary" were written on these lines; and Mr. Laurie Magnus's "Dictionary of European Literature" takes a like direction and aim. It is, moreover, an application of scientific method to vast and scattered material.

Such a task is, of course, stupendous in no hackneyed sense of that word. The mere labour of reading, collecting, and collating the mass of material demands great industry and patience; but the crux of the difficulty comes when the digested and assimilated mass has to be turned into the flesh and blood of a live book. This is the ultimate test by which the work is to be judged. Have we here only another catalogue, exact and compendious, if you like, but still only a good catalogue of facts? Or are there spaciousness of view and single-mindedness of aim that give a unity to the whole? So far as we have been able to judge, the book stands this severe test.

The bulk of the articles consists of well-documented and up-to-date biographico-critical accounts of authors in all countries, with résumés of the literary history of each country under its own name. The author throughout combines an unflagging spirit with a calm and, so far as we have seen, an unbiassed critical judgment, and he is very often singularly happy in his mental picture of the writer whom he is treating. It would be pointless on the part of a reviewer to complain that too little space is given where he would have liked, or expected, more; and too much where his own taste and judgment would have led him to give less. Such personal disappointments are inevitable in all dictionaries and anthologies. It is perhaps only less pointless to say that, rarely here and there, we could have spared a little of the space devoted to the personal side of the particular author being treated, so as to have a fuller exposition of his work and message. This is, however, but by the way.

A valuable feature of the book is supplementary to these biographical and critical accounts of authors. In ordinary histories of English literature, or studies of single authors, names occur which are imperfectly understood. Thus, Renaissance, Reformation, Humanism, Romance, and similar terms cross several centuries and all countries. They are English names for European phenomena, and the English student is commonly very inadequately seized of their European meaning and value, and of the relation borne by the English part to the European whole. Within the circumscribed limits set by a single volume, Mr. Laurie Magnus has given a vivid and considerable elucidation of these generic phenomena. The reader may well turn immediately, for example, to the article on "Nature, Natural, Naturalism."

Another important set of topics is that of the classical writers. Tennyson is called Virgilian, and so on, and the metaphor is accepted easily, but the European vogue of Virgil, Cicero, Plato, and the rest cannot be grasped by students unless they consult special textbooks, usually in a foreign tongue. The "Dictionary of European Literature" endeavours to supply this information under the name of each classical writer. In such questions, too, as the influence of "Climate," the changing treatment of "Woman," the literary motive of "Death," there are similar articles bringing together information from various places and times, and fusing the constituent parts into a combined and intelligible whole.

The admirable preface to the book should be read to gather its purpose and aim. Its sub-title tells us the book is "designed as a companion to English studies." In our judgment it is, taking it all in all, a pleasant yet learned, stimulating yet judicious, companion, of fine but tempered enthusiasms. Its best virtue, perhaps, is that, as guide, it gives us zest to roam free and know more.

Pyrometric Methods.

(1) *Methods of Measuring Temperature.* By Dr. Ezer Griffiths. (Griffin's Scientific Text-Books.) Second edition, revised. Pp. xii+203. (London: Charles Griffin and Co., Ltd., 1925.) 10*s.* 6*d.* net.

(2) *Pyrometers: Recent Developments in Pyrometric Appliances and Methods for Calibrating Temperature-Measuring Instruments; with Notes on Electric Furnaces.* By Dr. Ezer Griffiths. Pp. xi+126. (London: Sir Isaac Pitman and Sons, Ltd., 1926.) 7*s.* 6*d.* net.

THERE are few physical investigations which do not call at some stage for a determination of temperature, although the conditions of the experiment and the accuracy demanded may vary within very wide limits. Hence the modern development of thermoelectric, resistance, optical, and radiation pyrometers, supplementing the mercury thermometer and referred to the gas thermometer as a standard, the latter instrument being too troublesome for practical routine determinations. So many industrial processes also now require accurate measurements of temperature that manufacturing works will be found to possess installations which would formerly have been seen only in a physical research laboratory. There is thus a need for scientific descriptions of the methods of measuring temperature, for the use of the industrialist as well as of the laboratory worker. The methods must be understood if they are to be employed to any purpose, and serious errors result from the use of instruments the principle of which is imperfectly realised.

(1) The first edition of Dr. Ezer Griffiths's book was welcomed as a valuable survey of modern methods of measurement of temperature. It has now been revised, mainly in the sections which deal with optical pyrometry. It gives a full account of most of the devices which find application in practice, and is not encumbered with descriptions of obsolete or untrustworthy methods. The diagrams showing the electrical circuits are very clear, and the directions for the use of the instruments are satisfactory. Since the practical metallurgist has to calibrate his instruments mainly by the determination of fixed points, a table of such points might well have been given, the particulars on this subject being rather scanty. Full details up to 450° are given, but for the higher temperatures fuller use might have been made of the recent work of the U.S. Bureau of Standards. References to the literature are given at the end of each chapter.

Experience in industrial pyrometry proves that two sources of error are most commonly found. Thermocouples undergo changes in course of use, so that the value of their indications does not remain constant. As a pyrometer which reads wrongly is worse than none at all, it is important that calibration should be repeated at intervals, and that the metallurgist should be fully acquainted with the methods of checking the accuracy of his instrument. The procedure is simple, and this work gives full particulars. The other error is less obvious. In a reheating furnace, for example, the temperature is never uniform throughout, and it is of the utmost importance that the pyrometer should be so placed that the temperature indicated should be that of the object being heated. This is often not the case, and one may sometimes see furnaces in which the temperature of the objects heated obviously differs by 100° or more from that shown by the pyrometer, owing to the placing of the latter. In a book of this kind, a chapter on the subject of the placing of pyrometers in the spaces being heated would have been useful. The accuracy of the eye of a trained man, such as a steel hardener, is remarkable, and it is to be hoped that the more general use of pyrometers will not lead to a complete abandonment of the practice of visual determination of temperature, this being often a valuable control of the indications of a pyrometer.

(2) Dr. Griffiths's second book contains a very brief outline of the most modern types of pyrometer, together with some special applications to difficult practical problems, such as the determination of the temperature of rapidly moving parts and of the windings of transformers. It will be found useful in industrial works, the descriptions being clear and to the point. A short chapter is devoted to furnaces for high temperatures. The account of the Ajax high-frequency induction furnace does not quite accurately describe the latest type, but it is well that this very useful method of attaining high temperatures should be mentioned. The only optical pyrometers described are those of the disappearing filament type, the author rightly regarding this as by far the most simple and trustworthy.

C. H. D.

The Earliest Herbal written in England.

The Herbal of Apuleius Barbarus, from the early Twelfth-century Manuscript formerly in the Abbey of Bury St. Edmunds (MS. Bodley 130). Described by Dr. Robert T. Gunther. Dedicated and presented to the President and Members of the Roxburghe Club by Edward George Spencer-Churchill, 1925.

BOTANISTS and palæographers are greatly indebted to the Roxburghe Club, and especially to Capt. E. G. Spencer-Churchill, for the magnificent facsimile copy of the "Herbal of Apuleius Barbarus," which has been reproduced photographically from the

original manuscript in the Bodleian by the Clarendon Press.

The value of this publication is not only greatly enhanced, but is also rendered of extraordinary interest, since Dr. R. T. Gunther has compiled a very valuable introduction in which the history of the "Herbal" and its relation to other herbals is fully discussed. The appendices are of equal value, as in Appendix I. the herbs described in the Bodley MS. are set out in order, with notes on the text and identifications of the plants described and figured, so far as this has been found to be possible. This difficult work of identification of figures, often copied from earlier works, has been done partly by the late Mr. James Britten, whose name is an assurance of the meticulous care with which the work has been done, and after his death by Dr. A. B. Rendle.

The interest of the MS. Codex lies in the fact that it includes the earliest herbal believed to have been written and illustrated in England, the date being about A.D. 1100; also that it once belonged to the Abbey of Bury St. Edmunds. The history of the Codex and its wanderings is given, in the early pages of the introduction, up to the time that it was presented to the Bodleian some 220 years ago. But for Dr. Gunther having consulted the manuscript in an endeavour to trace the origin of a drawing of the "Saxifrage of the Antients," copied from an old manuscript by John Goodyer, the Codex might still have reposed, receiving scant attention, in Bodley's library.

The illustrations amply justify the reproduction of the manuscript in facsimile. Most are based on traditional 'Dioscoridean' drawings of remote antiquity. The most complete series of such early plant drawings are to be found in the manuscript illustrated about A.D. 512 by Greek artists as a wedding gift for Julia Anicia, daughter of Flavius Anicius Olybrius, Emperor of the West. Some of these with their descriptions were no doubt derived from Crateuas' paintings of plants executed in the first century B.C., combined with the text of the "Materia medica" of Dioscorides. The paintings illustrating these early herbals appear to have been copied one from another without reference, except in rare cases, to the plants, with the result, as may be seen in Apuleius's "Herbal," that many have become so conventionalised as to be scarcely recognisable.

It is much to be regretted that certain chapters are missing from this "Herbal," in particular those describing the mandrake and the *Herba Basiliske*, but this defect has been remedied by including in the introduction a reproduction in colour of the mandrake from MS. Ashmole 1431, and descriptions of both plants in English from Cockayne's translation of the Anglo-Saxon "Apuleius." Two very interesting plates of German figures from an Italian MS. in the Library of Trinity College, Cambridge, illustrating the mandrake, rosemary for sore eyes, devils being cast out by a herb, and *Herba Delfion* or (?) delphinium, with the flowers transformed into dolphins or fishes, conclude Dr. Gunther's valuable introduction.

The value of the appendix lies in the citation of the titles of the chapters and the modern botanical names, reprinted from Cockayne's edition of an Anglo-Saxon version of the "Herbal," the Dioscoridean and Theophrastan synonyms, notes on the colours of the roots, leaves and flowers in the illustrations in the MS., and suggestions as to the correct identification of the figures. These, as might be expected when it is possible to suggest determinations, are often entirely different from the names given in the Anglo-Saxon version. The figures are all of interest, but some, such as *Cotyledon umbilicus*, *Herba Narcissus* and *Herba Hipperis*, show how much has been lost by repeated copying.

In the second appendix a useful table is given showing the variation in the numerical order of the plants described in the Ashmole 1431, Anglo-Saxon MS. V., and the Bodley MS. 130, here reproduced, and the printed edition of the "Herbarium of Apuleius" of 1526. A complete index concludes this very interesting volume.

Our Bookshelf.

Chemical Synonyms and Trade Names: a Dictionary and Commercial Handbook. By William Gardner. Second edition, much enlarged. Pp. vi+271+56. (A companion volume to the first edition, containing the additional Synonyms in the second edition, is also issued. Pp. 56. 7*s*. 6*d*. net.) (London: Crosby Lockwood and Son, 1925.) 30*s*. net.

THE number of entries in this dictionary is now between 16,000 and 17,000, several thousands being new to the second edition. The added material has, for an obvious reason, been placed at the end of the book with a separate pagination, but owners of the first edition may purchase it in the form of a companion volume. From the outset it was clear that this publication would meet a want, and we know of no book which covers the same ground so usefully and, withal, so accurately. Not only will it appeal to those who traffic in chemicals and their raw materials, but the general reader will also find in it much to interest him, *e.g.* the composition of many commodities that he uses in daily life: the ingredients of soaps, water-softeners, perfumes, dyes, drugs, disinfectants, and so forth.

The expert, knowing the extreme difficulty of making such a dictionary all-inclusive, will not expect to find everything he seeks, and he may be disappointed not to find more information concerning the nature of proprietary articles; but he will be interested to learn that the excellent disinfectant which has usurped the name

of one of England's most famous poets, owes its efficacy to the presence in it of sodium hypochlorite. It is common knowledge that chemists can no more answer the question: What is a chemical? than the related one: What is a chemist? Nevertheless, we believe that most of them would be surprised to find in a dictionary of chemical synonyms such names as briquettes, hop-flour, molasses, gin, and Apollinaris!

Contributions to the Ethnology of the Kwakiutl. By Franz Boas. (Columbia University Contributions to Anthropology, Vol. 3.) Pp. vi+357. (New York: Columbia University Press; London: Oxford University Press, 1925.) 21*s.* net.

THIS volume consists of Kwakiutl texts with translations for which the material was obtained from a half-blood Indian of Fort Rupert, British Columbia, who speaks Kwakiutl as his native language and has been trained in phonetic writing by Prof. Boas himself. It is a continuation of Vol. 35 of the annual report of the American Bureau of Ethnology. The greater part of the texts deal with the social organisation of the people, and they have this advantage for the student, that they deal with concrete examples, described in minute detail, of such social elements as inheritance and succession, naming, marriage, and the like.

The section which is particularly welcome, however, is the transcript of sixty-five dreams. These are of interest from the point of view of both the psychologist and the student of religion. A number of the dreams are of an ordinary type merely reproducing everyday activities. Of the others, some describe relations with the dead. In one a son was told by his father of his discomforts in the spirit world, and on waking he burned two pairs of blankets and food for the soul of his father. Two dreams deal with the Shaman's crystal: in one the dreamer finds a crystal in the stomach of a seal; in the second a crystal is forced into the dreamer's body by a gull which had spat it out. A man well known as a 'true' dreamer anticipated the news of the death in England of a former missionary. It is stated that this dream was told to the writer the morning after its occurrence, and the letter containing the news of the death not received until some time after. The familiar nightmare of falling from a height is recorded. A number of the dreams are interpreted as foretelling epidemics and death.

The Anglo-Saxon Cemetery at Girton College, Cambridge: a Report based on the MS. Notes of the Excavations made by the late F. J. H. Jenkinson, M.A. By E. J. Hollingworth and M. M. O'Reilly. Pp. vii+38+12 plates. (Cambridge: At the University Press, 1925.) 4*s.* net.

THE Anglo-Saxon Cemetery at Girton College, which lies a few yards north of the Roman road from Cambridge to Godmanchester, was discovered in 1881 in the course of building operations. About 150 cremation interments and 75 to 80 skeletons were then brought to light. Further discoveries were made in 1886; but while the authors of the book have been able to avail themselves of the careful notes of the late Mr. Jenkinson from the earlier excavations, the conditions under which the later examination was made precluded anything like a detailed record. The authors have performed a pious duty to their College and a real service to archæology in working up the material provided by these notes and by the actual objects, some on loan from Girton College, which are now in the University Museum of Archæology and Ethnology at Cambridge. The cemetery was evidently of considerable size, and presents several points of considerable interest. Cremation and inhumation were practised contemporaneously throughout the whole period of pagan Saxon occupation. A fragment of pottery suggests that the site may have been occupied so early as the Middle Bronze age, and two Roman cremated burials were also found.

Die Schalltechnik. Von Dr. Richard Berger. (Sammlung Vieweg, Heft 83.) Pp. iv+115. (Braunschweig: Friedr. Vieweg und Sohn A.-G., 1926.) 8 gold marks.

IT is strange that in text-books dealing with the practical applications of our knowledge of sound, each author considers it necessary to employ a special vocabulary to describe sound phenomena, and each author employs a different one. This monograph provides an illustration, for the first part of it is devoted to well-known theories of the propagation and production of the various types of waves, which are described in a new nomenclature. Theory is then somewhat abruptly set aside and a description of practical technique is commenced. This part of the book is much more helpful, for it describes work carried out in Germany which had for its object the prevention of noise with moving machinery, and the insulation of other portions of a building from such noise. The work of Sabine and Watson on the acoustics of buildings is touched upon, but the list of absorption coefficients given is not up-to-date. Sound-signalling, including the effect of wind, sound-ranging and direction finding are also described, the work of the Danish and German artillery sections providing most of the material. The final section deals with the work of Miller in the United States on the analysis of sounds produced by musical instruments and by the human voice.

Volumetric Analysis: with a Chapter on Simple Gravimetric Determinations. By A. J. Berry. (Cambridge Physical Series.) Third edition. Pp. vii + 151. (Cambridge: At the University Press, 1925.) 9*s.* net.

THIS work was first published in 1915, and the fact that it has reached a third edition, in spite of the appearance of a large number of books covering the same ground, is good testimony to its popularity and value. The treatment is clear and scientific, an excellent feature being the judicious interweaving of explanatory theoretical matter with the practical instructions. In the recent edition is included a new chapter on simple gravimetric determinations which contains much useful advice to the young student concerning general principles. The author is under no illusion that analytical chemistry can be taught exclusively from books: it is a craft as much as a science, and in the learning of it, practice in doing must take precedence over theoretical explanations, important as these are at the proper stage. It is a pleasure to note the author's strong recommendation of Masson's method for standardising hydrochloric acid with Iceland spar, which is not only very simple but also, as he states, yields results of extreme accuracy.

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.*]

The Transmutation of Elements.

In a letter to NATURE of January 30, 1926, Dr. Davies and Prof. Frank Horton give some considerations about the transmutation of mercury and lead which agree completely with those given by me in a lecture delivered in Amsterdam on January 29, 1926.

I considered the two possibilities of transmutation by absorption of electrons or by disruption of the atomic nucleus. Since I thought the latter more probable in the cases mentioned above, I laid most stress upon this possibility and gave the following considerations :

Aston found the atomic weights of the isotopes of mercury to be 202, 209, 199, 198, 201, 204. Assuming that, for example, the isotope 201 suffers a transmutation into gold by disruption of the nucleus, this process can be indicated by the following equations :

$$\begin{aligned} \mathrm{Hg} - a - \theta &= \mathrm{Au} \\ \text{atomic weight } 201 - 4 &= 197 \\ \text{atomic number } 80 - 2 + 1 &= 79 \quad . \quad . \quad (1) \end{aligned}$$

or

$$\begin{aligned} \mathrm{Hg} - 4\mathrm{H} - 3\theta &= \mathrm{Au} \\ 201 - 4 &= 197 \\ 80 - 4 + 3 &= 79 \quad . \quad . \quad . \quad (2) \end{aligned}$$

In the case of the transmutation of lead into mercury, the inactive isotopes having the atomic weights 206, 208 and 210, we may assume, for example, that the isotope 206 suffers a transmutation giving an isotope of mercury :

$$\begin{aligned} \mathrm{Pb} - a &= \mathrm{Hg} \\ 206 - 4 &= 202 \\ 82 - 2 &= 80 \quad . \quad . \quad . \quad . \quad (3) \end{aligned}$$

But we may also assume that the other isotopes 208 and 210 undergo a transmutation. In that case we obtain :

$$\begin{aligned} \mathrm{Pb} - 2a - 2\theta &= \mathrm{Hg} \\ 208 - 8 &= 200 \\ 82 - 4 + 2 &= 80 \quad . \quad . \quad . \quad (4) \end{aligned}$$

and

$$\begin{aligned} \mathrm{Pb} - 2a - 2\theta &= \mathrm{Hg} \\ 210 - 8 &= 202 \\ 82 - 4 + 2 &= 80 \quad . \quad . \quad . \quad (5) \end{aligned}$$

In the case of the transmutation of lead into thallium we can assume, for example, the following process :

$$\begin{aligned} \mathrm{Pb} - a - \theta &= \mathrm{Tl} \\ 208 - 4 &= 204 \\ 82 - 2 + 1 &= 81 \quad . \quad . \quad . \quad (6) \end{aligned}$$

We see that of the different transmutation possibilities, (3) is most simple. Moreover, I suspected this process could be expected first, as lead is the end-product of the spontaneous radioactive transformations.

In connexion with these considerations I pointed out that the best method of learning the nature of the transmutation is to examine spectroscopically whether the process is accompanied by the formation of helium or hydrogen, and to determine the atomic weight of the heavier products.

With a new apparatus which promised to enable us to study the problem successfully, my co-worker Dr. Karssen and I carried out a series of new experiments. While using the old quartz-lead lamp, negative results were obtained only if the current strength was lower than 15 amperes, but now, with our new lamps of somewhat different dimensions, spectroscopically negative results were found even using ±60 amperes. The lamp showed distinctly different properties in burning and sparking. This proves that the phenomena taking place in the quartz-lead lamp depend on influences unknown until now, so that the transmutation in the quartz-lead lamp is not so easy to reproduce as we expected.

In connexion with this subject we are studying now the quartz-lead lamp more closely, and in the meantime we are applying our second sparking method, which we intend to extend to still higher voltage and higher current-densities.

Though we have already secured quantitative data, we prefer to publish the results later. A. SMITS.

Laboratory of General and Inorganic Chemistry,
University of Amsterdam,
April 3.

Potassium and the Heat of the Earth.

It has been widely recognised that the disintegration of the uranium and thorium in rocks has exerted a profound and probably controlling influence on the earth's thermal history. Hitherto, however, it has not been realised that potassium as an emitter of radiothermal energy is in the aggregate of the same order of importance as uranium or thorium. This surprising result has emerged in the course of a joint inquiry into the geological significance of the radioactivity of potassium and rubidium. The latter element is negligible geologically on account of its extreme rarity, despite the fact that its total activity is greater than that of an equal amount of potassium. Nevertheless, we have included rubidium in our discussion, since measurements of the activity of potassium have usually been compared with those obtained with rubidium, and our preliminary estimate of the amount of heat generated by the potassium in rocks depends on that comparison.

The β-rays emitted by rubidium are fairly homogeneous ; their velocity has been estimated from experiments on their deflexion in a magnetic field (Bergwitz), and by comparison of their absorption coefficient with those of radioactive rays of known velocity (Hahn). These experiments point to a velocity of 0·60 c, the corresponding kinetic energy of a β-ray from rubidium being $2{\cdot}04 \times 10^{-7}$ ergs. In the case of potassium, Hahn has concluded that the average velocity of the β-rays cannot differ much from 0·90 c. We probably make adequate allowance for the heterogeneous nature of the potassium rays by assuming for them the value $\mu = 20$ cm.$^{-1}$ aluminium. Using this result in conjunction with Lenard's curves of absorption of β-rays of different velocities, we obtain for the average velocity of the potassium rays the value 0·85 c, a result in substantial agreement with that of Hahn. The average kinetic energy of a β-ray from potassium is thus $7{\cdot}30 \times 10^{-7}$ ergs.

We next require the half-periods or the disintegration constants of rubidium and potassium. Hahn and Rothenbach compared the activity of the β-rays from rubidium with that of the β-rays from UX_1, and thus found for rubidium a half-value period of $0{\cdot}7 \times 10^{11}$ years, this result being uncorrected for the different values of the number of ions per cm. and the Loschmidt numbers (per gm.) for the substances compared. Applying the necessary corrections, we find $T_{Rb} = 1{\cdot}4 \times 10^{11}$ years. Hoffmann also has compared the activity of rubidium and of potassium with that of uranium, using two different methods, and he concludes that his results are in agreement with that of Hahn and Rothenbach, though slightly lower. Correcting Hoffmann's results to take account of the

absorption of the rays in his apparatus and in the active film employed, we find $T_{Rb} = 1{\cdot}1 \times 10^{11}$ years from the results of the first method, and $T_{Rb} =$ *ca.* $0{\cdot}8 \times 10^{11}$ years from those of the second. The half-value period of rubidium cannot therefore differ much from 10^{11} years, and we have adopted this value as the most probable approximation.

The data for potassium are not yet established with the same degree of accuracy. Estimates of the total activity of rubidium relative to that of an equal weight of potassium vary between 7·0 and 1·4, indicating that the half-period of potassium lies between 50 and 11 times that of rubidium. Fortunately, Hoffmann's delicate measurements (referred to above) reduce the range of these extremes very considerably. His two methods gave results indicating that the half-period of potassium is between 14 and 22 times that of rubidium, the lower value being of superior reliability. Taking all the available data into consideration, we conclude that a ratio of about 15 appears to be the most representative in our present state of knowledge. This gives for the half-value period of potassium, $T_K =$ about 15×10^{11} years.

Element.	Uranium	Thorium	Potassium	Rubidium
Loschmidt Number, N, atoms per gram . .	..	..	$15{\cdot}5 \times 10^{21}$	$7{\cdot}09 \times 10^{21}$
Half-value Period, T, in years	..	..	15×10^{11}	1×10^{11}
Disintegration Constant, λ, year^{-1}	..	..	$4{\cdot}6 \times 10^{-13}$	69×10^{-13}
Annual No. of Atoms disintegrating per gram. $n = \lambda N$	..	..	$7{\cdot}1 \times 10^{9}$	49×10^{9}
Kinetic Energy, E ergs per β-ray	..	..	$7{\cdot}30 \times 10^{-7}$	$2{\cdot}04 \times 10^{-7}$
Energy liberated per gram per year. $nE/(4{\cdot}19 \times 10^{7})$ cal.	(7900×10^{-4})	(2300×10^{-4})	$1{\cdot}24 \times 10^{-4}$	$2{\cdot}38 \times 10^{-4}$
Contents in grm. per gram of average igneous rock .	6×10^{-6}	15×10^{-6}	$26{,}000 \times 10^{-6}$	$m \times 10^{-6}$
Heat generated in cal. per gm. of average rock per year .	$4{\cdot}74 \times 10^{-6}$	$3{\cdot}45 \times 10^{-6}$	$3{\cdot}22 \times 10^{-6}$	$2{\cdot}38\ m \times 10^{-10}$

We are now in a position to calculate the annual heat production from one gram of potassium and rubidium respectively, and consequently to calculate further the annual heat production due to the presence of these elements in one gram of any rock of known composition. The calculations are embodied in the accompanying table, and, for comparison, the results for average igneous rock are given, and the annual heat productions due to uranium and thorium (together with their disintegration products) per gram of rock are included.

The geological consequences of the radioactivity of potassium are clearly of great importance, for the heat generated within the rocks is now found to be considerably greater than the amounts hitherto calculated from uranium and thorium alone. For average granite the heat annually generated per c.c. becomes 40×10^{-6} calories instead of 30×10^{-6} calories. For average plateau-basalt the corresponding new estimate is 12×10^{-6} cal. per year instead of 9×10^{-6} cal.

A rough estimate of the mean thickness of the granitic layer of the continents can be arrived at by equating the amount of heat escaping at the surface with the heat generated within the granitic layer. Taking a column of unit cross-section, the heat lost per annum averages 60 calories, and evidently this can be entirely supplied by 15 km. of average granite. Seismic data have until recently been held to indicate about 30 km. for the average thickness of the granitic layer of Eurasia (Oldham, Wiechert, Angenheister, Gutenberg, and others). Within the last few months, however, Stoneley has shown that dispersion affects the validity of estimates such as that of Gutenberg, and Jeffreys has found that the necessary corrections reduce the estimates of thickness to 15 km. Recognition of the effects due to potassium thus brings about a satisfactory accordance which otherwise could never have been achieved.

Beneath the granitic layer, heat is supposed to accumulate until the latent heat of basaltic material is supplied, and fusion takes place. The average time required for the accumulation of 270 cal. per c.c. of basaltic material now becomes 22·5 million years instead of 30 million years. These figures are, of course, highly speculative, and are introduced merely to illustrate the geological significance of potassium.

Our investigation was partly stimulated by the possibility that the radioactivity of potassium might have been of considerably greater effect in early geological time than it is now, and so have led to the extensive intrusions of granite that everywhere characterised the earlier pre-Cambrian eras. It is, however, not yet possible to draw any such conclusion; nor will it become possible, unless the activity is found by future investigations to be confined to a still undiscovered isotope which has been appreciably wearing out through geological time.

ARTHUR HOLMES, The University, Durham.
ROBERT W. LAWSON, The University, Sheffield.

April 5.

Use of Thermit in Ice-Breaking.

THE remarkable results obtained by Dr. H. T. Barnes and his co-workers at Oil City and Franklin in alleviating disaster owing to ice-jams in twenty-four miles of the Allegheny River have received widespread attention.

The effectiveness of the undertaking is guaranteed by competent engineers on the spot who watched all the operations, and the success of the thermit treatment was even greater than Dr. Barnes himself had anticipated.

The physical aspect of the action of thermit on ice is an interesting one which deserves consideration altogether apart from the question of ice engineering. One pound of thermit when ignited gives 1500 British thermal units, less than a pound of coal. Hence, if a container of 100 lb. is ignited, 150,000 B.T.U. is released, and, as it takes eighty of these units to melt a pound of ice, we see at once by division that a little less than one ton of ice (about 1900 lb.) will be melted; or, a ton of thermit will melt under favourable conditions 95 short tons of ice.

This in itself is an important result, because, if 95 tons of ice are melted at the right time in the right place, a very considerable effect may be produced where there is a current of water to push the ice down a river. The above consideration is of course at once grasped by every engineer and physicist.

The remarkable effects which appear to be produced by the action of thermit packed in solid ice is clearly not to be referred mainly to the above. Thermit (iron oxide and powdered aluminium) ignited in the

open attains rapidly a temperature of about 3000° C., and there is then nothing in the way of an explosion.

When, however, thermit is ignited, *closely surrounded by solid ice*, the photographs obtained by Dr. Barnes indicate a highly explosive action quite different from that in the open. Here we have to deal perhaps with the results due to an *impulse* rather than with either heat or with pressure over a considerable interval of time. Those who have tested a new gut fishing-cast and have proved that it will stand a steady strain of six pounds weight are familiar with the experience that it may snap when they strike quickly at a half-pound trout. A tap on a pin may fracture a block of ice which has withstood a blow from an axe. A small hot flame will fracture a large plate of glass. These are examples of impulsive effects, quick action being essential.

Now let us return to the container of 100 lb. of

FIG. 1.—Ice exploding due to a charge of 90 lb. of thermit in the River St. Lawrence at Chimney Island, below Ogdensburg, N.Y. The mine was placed four feet down in slush-ice underhanging to a depth of eight feet the solid surface ice two feet thick. The bright flames forty-five feet high give a reversed image in the photograph, and, below, the disrupted ice is seen raised six feet. (Photo by W. A. Connolly, Morrisburg, Ontario.)

thermit yielding 150,000 B.T.U., and let us further recollect that each B.T.U. can do work amounting to 778 foot-pounds. On multiplying these numbers together we arrive at 117,000,000 foot-pounds or about 60,000 foot-tons, sufficient to raise a 10,000-ton ship vertically six feet against gravity. Imagine now a vessel weighing 10,000 tons dropped six feet on to a river seriously blocked with ice. There would be smashing and cracking of the ice in all directions, and, with water pressure behind them, blocks of ice might well be released. It is further desirable to contemplate not only the explosive action of the thermit, but also the effect of the radiation, from a high temperature source, which may pass for a considerable distance through the ice, causing changes which recall Tyndall's famous experiment on 'flowers of ice.' Much of the water in a river is above the freezing point, and if this is allowed to seep into the enlarged surface of partially disintegrated ice, melting is accelerated. It appears to be conceded by engineers that thermit is better than black powder, and black powder than dynamite, for ice removal.

The interesting question is to what extent we have to attribute the effects of thermit to (*a*) heating, (*b*) explosions, (*c*) high temperature radiation. It is on this account, and for the further reason that there is an actual possibility of disintegration of ice into atomic gases, that the experiments on thermit are of such a highly interesting character to the physicist no less than to the engineer. There is, of course, no suggestion that the laws of conservation of energy are not obeyed. Yet it is clear that the investigation of the action of thermit presents a problem of great importance which requires money, time, and skilful research work in the laboratory as well as in the field.

A. S. EVE.

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The Problem of X-ray Line Intensities.

REFERRING to the experiments mentioned by the present writer in recent issues of NATURE (January 30, p. 153; March 27, p. 448), and other work not yet published, we have had on several films and on one plate lines of wave-lengths 1·040 and *1·038*[1] respectively. It seemed impossible to regard these lines as being due to mercury, since either the HgLa_1 or the Hg$L\beta_1$ line has not been present. The films and plate represented good photography, and the exposures were over a wide range, so that these lines fell about midway.

The problem is to account for these lines, which will be referred to collectively as the '1·040 line.' This line does not always occur, even faintly, on changing the substance on the copper anticathode, but it does appear when the substances are such that they might contain an element of atomic number 87 (see first citation above).

We have had lines *1·038* and *0·930* on one plate, and 1·040 on films as stated above; these occurring when the presence of bromine seemed out of the question, and the *0·930* line has not yet appeared except once and then with the *1·038* line. These two lines were obtained under the following conditions: Commercial potassium phosphate (monobasic) melted on the anticathode. Optical spectrum revealed the presence of calcium only as an impurity. X-ray exposure 12 hours. Voltage 60,000. Current 5 to 8 milliamperes. Shearer tube with water-cooled parts. Müller spectrograph. Plate distance 80·04 cm. Slit 0·1 mm. Angle of oscillation 5°-17°. Oil backing pump and mercury pump used. All lines clear and well defined. Plate clear with no fogging except along one side. The bromine absorption edge sharp and almost completely obscured along part of its length by side fogging (see below).

Some further incidental particulars are: The *0·930* line was weak compared with the *1·038* line. Three copper-anticathode lines were present, counting the a_2 and a_1 lines as one, which were resolved. The characteristic copper lines were very strong and had so-called satellites on the longer wave-length side, which were probably due to an imperfection in the rocksalt crystal. The only other lines were weak lines *1·436* and *1·242*, probably due to the zinc and mercury, the former from the brass of the apparatus and the latter from the mercury used in exhaustion—as might be expected with a 12-hour run.

It is to be noted that the RbKa_2 line has a wave-length of 0·928. Experimental error in the measurements cited above 0·003. If *other* experiments had given evidence of bromine being present in the tube, or in the compounds used, the above line could be expected, for the BrKa_1 line is 1·0377.

[1] Accurate micrometer measurements have been made in those cases where the values are given in italics, all of which are in Ångström units; and the bromine absorption edge has served as a check in measuring the region between it and the Cu$K\beta_1$ line.

It has occurred to the writer that whenever a very weak radiation, corresponding in wave-length closely with that of a Br*K* line — perhaps an α_2 incident radiation—falls on a film or plate, the bromine in the emulsion, or the emulsion in conjunction with the bromine, is stimulated into greater photographic sensitivity and a comparatively strong line appears, especially under the conditions of our experiments, *e.g.* long exposure.

This hypothesis would seem to give a satisfactory explanation of the appearance of the ' 1·040 line.'

As an incidental feature, on the plate we had a slight fogging along one side or edge which partly obliterated the *0·930* line, showing that slight darkening may obscure a weak line, as was stated by the writer in connexion with the suspected $87L\beta_1$ line (see citations above). The stronger lines were not, however, reduced in intensity by the slight side-fogging.

In conclusion, it will be seen that if the above view is in the main true, then the following radiations, in terms of lines, though very weak, would give rise to more or less strong lines: Hg$L\beta_2$ 1·0375, As$K\beta_2$ 1·038, (87$L\alpha_2$ 1·039), (Br$K\alpha_1$ 1·0377), Tl$L\beta_4$ 1·0371; Rb$K\alpha_2$ 0·9277, (Br$K\beta_1$ 0·931), Cd second order $K\beta_2$ 0·928. The brackets indicate complete exclusion from consideration or doubt in respect of stimulation. Some of these radiations can be eliminated by control experiments, so that it may be possible to find out the element which is operative if the effect is not due to a complex of lines. The optical spectrum would be helpful here as a guide, but in our case it has not revealed an element corresponding with either of the two lines in question, as might be expected.

It seems important that the whole bromine X-ray spectrum (*K*) should be determined if there is anything in the idea here advanced.

Perhaps one of your readers would kindly offer a better explanation of the matter than here attempted, bearing in mind that there is a tendency for all the lines in question to be shifted perceptibly towards the longer wave-length side, and on this account our line 1·032 (*loc. cit.*) may be the same as the *1·038* line.

F. H. LORING.

Relative Intensities of the D_1 D_2 Lines of Sodium in Comets and in Low Pressure Laboratory Sources.

SODIUM D lines of emission were identified beyond any possible doubt in the heads of the following comets: Wells, (1882*a*); Great Comet, 1882 (1882*b*); 1910*a*; Halley's Comet (1910*c*); and Brooks' Comet, (1911*c*). The appearance of these lines has always been of temporary character at perihelion. The spectra of the first three comets were observed either visually or by means of a prismatic camera, so that the only reliable determinations of wave-lengths are furnished for the comets Halley and Brooks. The spectrum of the former was taken by E. C. Slipher (*Lowell Observatory Bull.* 52) with the slit spectrograph of Lowell Observatory, and that of the latter by W. H. Wright (*Lick Observatory Bull.* 209) with the Lick refractor.

Slipher gives for the sodium lines only one wave-length, 5891·9, which is sufficiently near $D_2 = 5890·2$. It seems as if the other component, D_1, was entirely absent, although there remains an element of doubt as to the sufficiency of the dispersion employed. If 5891·9 is merely a blend of D_2 and D_1, their relative intensities should be about 3·5 to 1.

In the spectrum of Brooks' comet, Wright found both components, D_2 with wave-length 5889·4, and D_1 with wave-length 5895·5. He says: "Both of the D lines are present, forming a close double, D_2 being much the brighter." The relative intensities were estimated as 3 to 1.

Thus there would seem to be good astronomical evidence to the effect that sodium D lines are present in the spectra of certain comets and that they show very unequal intensity, D_1 being much weaker than D_2. If we take into account that D_1 may blend with the band 5897·5 of high-pressure carbon monoxide, as suggested by Fowler (*Monthly Notices, R.A.S.*, **70**, 490, 1910), the contrast between D_1 and D_2 will be still greater. Laboratory conditions for the excitation of these high-pressure bands, however, would scarcely lead us to expect to find this spectrum in comets.

R. W. Wood has shown (*Phil. Mag* (6) **27**, 1018, 1914) that it is possible to excite D_2 by fluorescent methods with an intensity excessively greater than D_1.

One of us has recently observed the excitation of the D lines with relative intensities strongly suggestive of their appearance in comets, and under conditions of excitation which also are somewhat similar. The tube used was provided with a hot cathode about five millimetres in length, richly coated with oxides containing very minute traces of sodium as impurity. The anode was a nickel cylindrical Faraday cage entirely enclosed (except for an observation slot) in which the end opposite to and about one millimetre from the hot cathode consisted of iron gauze. This grid-plate combination was maintained about 200 volts positive with respect to the filament.

Using as high a filament temperature as could be safely maintained, and a residual gas pressure of carbon monoxide of about 10^{-5} cm. or less, the radiation inside the cage exhibits chiefly the comet-tail bands with traces of the Ångström bands of carbon monoxide. Close to the hot filament, however, the D lines can be observed with an estimated intensity ratio $D_2 : D_1 = 5$ when the sodium spectrum is brighter than the comet tail spectrum. As the partial pressure of the sodium decreases, however, this ratio becomes much larger and of the order of 25 to 1. Indeed, when the sodium spectrum is fainter than the comet-tail spectrum, D_2 is the only line which can be observed visually. Conditions here obviously suggest those of a comet near perihelion, and it is hoped that further experimental work may shed more light on this interesting phenomenon.

HARVEY B. LEMON.
N. T. BOBROVNIKOFF.
Ryerson Physical Laboratory,
March 17.

Applied Entomology.

I WRITE to invite attention to the state of applied entomology, which seems to be capable of improvement in Great Britain and in other countries. We entomologists, whose profession it is to control or destroy the insects which carry diseases of men and domestic animals, or destroy our crops, can indeed claim that we have met with a certain measure of success; but some of us feel that the success is much less than might be expected, in view of the great amount of work which is done.

Entomology may be divided into two parts—the study of form and the study of function. It is the former (anatomy, both of adults and of early stages, systematics, etc.) which leads to correct identification, and enables us to preserve an orderly arrangement in our study of the half-million species of insects which are already known. This is clearly of great importance, and on the whole one may say that it is well done. But the study of function—physiology in a wide sense of the word—is of even greater importance, because it is on a knowledge of all the vital activities of the insects that we base our control of

them. I believe that the physiology of insects has been done in a superficial and disjointed manner, and that the reason is that the majority of workers feel compelled to produce results of some obvious practical importance. I believe that real progress will not be made in applied entomology until this mistake is realised, and until we devote time and labour to the study of the fundamentals of insect physiology.

For example, we know that the spread of plague is to some extent influenced by the effect of temperature and humidity on certain species of fleas; but we do not understand why high temperatures are fatal to some insects, or whether the effect of humidity on insects should be measured as relative humidity, or as saturation deficiency, or in what other way. Again, we know that the greater part of the response of an insect to its environment can be analysed into a number of tropisms, which are relatively simple. We scarcely study these problems of psychology, though it is possible that if we knew the stimuli which control the insects' behaviour we could predict or even alter the behaviour. As an example of this, it has been recently shown that if certain stimuli, such as darkness, are supplied, a species of mosquito will come freely to lay its eggs in water containing arsenic, which is fatal to the larva as soon as it leaves the egg. Then, again, most of the poisons which we use are in favour because they are known to be toxic to vertebrates. We lave the fair face of Nature with copper sulphate, and then powder her with Paris green, but we cannot find enough time to make a thorough study of the toxicology of insects.

I believe that progress in the control of noxious insects is at present hampered by our ignorance of the physiology of insects in general. By physiology I mean not only the study of the functions of isolated parts of an organism, but also the extremely difficult task of understanding the relations between the living insect and the whole of its environment, inorganic and organic.

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The Anomalous Flocculation of Clay.

IN recent years it has become common to speak of the flocculation of clay by calcium salts as being 'anomalous,' the particular anomaly being that whereas clay suspensions containing a little sodium chloride are stabilised by the addition of sodium hydroxide, in the case of calcium the flocculation is said to be facilitated rather than repressed by the addition of the alkali. Careful experiments, however, made with a highly purified clay suspension, have convinced us that this anomaly does not exist, and that calcium and sodium compounds behave alike except in respect to the concentration required for flocculation. The following figures show the concentration in equivalents of cation required for flocculation to be half completed in one hour, this being determined nephelometrically:

	Concentrations multiplied $\times 10^4$.	
	Sodium.	Calcium.
All chloride	70	5·6
All hydroxide	480	16·8
Two equivalents of chloride to one of hydroxide	560	19·5

These results are parallel and do not suggest anything more than that compounds of calcium are much more powerful flocculants than those of sodium.

In carrying out this work, however, a much more interesting phenomenon has been noticed. If to a dilute clay suspension be added gradually increasing quantities of certain mixtures of chloride and hydroxide, and the effect on the flocculation or otherwise of the clay determined nephelometrically after one hour's standing, it is found that the flocculating effect first increases very rapidly with concentration, then rapidly falls off and then again increases without further falling off. The following table shows this for a few mixtures, and also exhibits the similarity in behaviour between sodium and calcium compounds. '+' means flocculated (one-half or more down in one hour), and '−' means no flocculation observed in an hour.

Conc. $\times 10^3$ for Sodium. Conc. $\times 10^4$ for Calcium.	5	20	40	60	80	100	120	140	160	180	200
NaCl : NaOH, 50 : 1 .	−	+	−	−	+	+	+	+	+	+	+
NaCl : NaOH, 175 : 1 .	−	+	+	+	−	−	−	−	+	+	+
$CaCl_2$: $Ca(OH)_2$, 2 : 1 .	−	−	−	−	+	+	+	−	−	−	+

In the case of sodium compounds, the phenomenon is exhibited with ratios for chloride to hydroxide varying between 25 and 175 to one: for calcium it is only shown in the neighbourhood of the ratio 2 to 1. Other mixtures do not show a minimum in the flocculation curves.

Interesting information is being obtained from the *p*H measurements of the mixtures at critical points, and it is hoped to publish a complete account of the observations shortly.

A. F. JOSEPH.
H. B. OAKLEY.

Wellcome Tropical Research Laboratories,
Khartoum, March 16.

X-ray Identification of the Higher Fatty Acids.

THE fatty acids of higher carbon content than stearic acid are of general interest because of their occurrence in oils and fats now employed for edible purposes. Ultimate chemical analysis of higher fatty acids is inconclusive, because of the very slight percentage differences in the elementary composition of these closely related homologous substances, but X-ray examination gives data which are more decisive (Müller, *Chem. Soc. Trans.*, 1923, **123**, 2043; Müller and Shearer, *ibid.* p. 3156).

In pursuance of our researches on acids from vegetable fats, including arachis or peanut oil (Morgan and Bowen, *J. Soc. Chem. Ind.*, 1924, 43, 346*T*; Morgan and Holmes, *loc. cit.*, 1925, 44, 108*T*, 219*T*, 491*T*), we have recently isolated from this oil an acid melting at 77° which has been shown by X-ray examination to be a C_{26} acid, almost certainly possessing an unbranched carbon chain. We are indebted to Dr. E. A. Owen of the National Physical Laboratory for the X-ray photograph.

This physical evidence confirms an observation published recently by Holde and Godbole (*Ber.*, 1926, **59**, 36), who have shown that arachis oil contains a hexacosoic acid (m.p. 79°), this acid giving by alkalimetric titration a molecular weight of 394 (calculated 396).

As the chemical constitutions of higher fatty acids from arachis oil have recently been a matter of controversy (Ehrenstein and Stuewer, *J. prakt. Chem.*, 1923, **105**, 199, and Cohen, *Proc. K. Akad., Wetensch., Amsterdam*, 1925, **28**, 630), we are now examining the chemical and physical properties (including crystal structure) of certain higher fatty acids having branched carbon chains of predetermined configuration.

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The Campaign against Prickly-Pear in Australia.

WORK OF THE COMMONWEALTH PRICKLY-PEAR BOARD.

By ALAN P. DODD, Officer-in-Charge of the Investigations.

THE Commonwealth Prickly-Pear Board was instituted in 1920 to study the possibilities of the control of the prickly-pear pest in Australia by means of biological agencies. Previous investigations had established the fact that in its native home, America, prickly-pear is attacked by various insects and fungus diseases that appear to be confined to plants of the cactus family.

The Board at once commenced operations in North America, and has employed investigators in that country since; a more or less comprehensive survey has been carried out in the cactus regions of the United States, and brief excursions have been made into Mexico. South America, Argentine and Uruguay have been explored to a considerable extent. In the present year more extensive operations are planned in Mexico.

During the earlier portion of the work, attention was paid to the fungus and bacterial diseases of the cactus family, but owing to the need for special research in this subject and the inadequacy of the Board's finances, the work was allowed to lapse temporarily. However, in 1925, a research scholar in mycology was appointed and has commenced studies in the laboratories of several universities in the United States.

THE WORK IN AMERICA.

The cactus family is botanically a rather isolated group, and has evolved a considerable insect fauna that appears restricted to plants in the family. In the United States alone, the Board's entomologists have made known more than sixty species of insects that are primarily cactus feeders; in Mexico and South America other species occur; a number of these has proved new to science.

The work in America consists of the study of the insects in the field, and the breeding and forwarding of numbers of reared material, free from parasitic enemies, of all species that promise to be of use in the control of prickly-pear in Australia. Before shipments are sent, tests are carried out with each insect in order to ascertain the possibility of its being able to develop on other plants. These tests have given interesting results, and more than one insect has been eliminated because the tests showed that it was capable of sustaining its life cycle on certain economic plants. The tests are repeated in Australia against economic plants and native trees.

To date, about forty different species of cactus insects have been forwarded to Australia, in most cases many thousands of each.

THE WORK IN AUSTRALIA.

In Australia the Board has established a central laboratory at Sherwood, near Brisbane, and field stations at Westwood, near Rockhampton, Chinchilla, two hundred miles west from Brisbane, and Gravesend, on the Moree-Inverell railway in New South Wales. Sherwood acts as the quarantine station where the insects are received from America and bred through one generation to eliminate further the risk of the introduction of parasites that might exercise a serious check on the rapid multiplication of the desired insects; the bred material is then distributed to the field stations. The equipment at the field stations consists of insectaries and a great many breeding cages of various types. The function of these stations is to rear the insects in sufficient numbers to permit of liberations in the open.

Throughout the investigations one of the chief difficulties has been the acclimatisation of the introduced insects. It must be remembered that the seasons in North America are the reverse of those in Australia; thus, when an insect should be hibernating in the North American winter it must be actively feeding in an Australian summer. With most of the insects, repeated shipments over a period of two or three years have been necessary to secure their establishment in the rearing cages; indeed, certain species have quite failed to adapt themselves, either through the unsuitability of caged conditions, or to differences in climate.

Another phase of the work has been the study of the adaptability of the insects to Australian prickly-pears. The two main species involved in Australia are the common pest pear, *Opuntia inermis*, and the spiny pest pear, *O. stricta*; lesser pests are the velvety tree pear, *O. tomentosa*, the smooth tree pear, *O. monacantha*, and the tiger pear, *O. aurantiaca*, while several other forms are found in scattered quantity. Very few cactus insects will attack all prickly-pears indiscriminately; most of them show a decided preference for certain forms, and in some cases will readily attack one pear and refuse to live on another.

INSECTS SUCCESSFULLY INTRODUCED INTO AUSTRALIA.

Of the insects successfully introduced into Australia, the most widely known are the cochineals, of which the most important is the wild cochineal, *D. tomentosus*. Three strains of this insect have been brought into the country from Texas, Arizona, and Chico, California, the two first by the Board, the last by independent action. All three will live readily on the two chief pest pears, but the virulence of the attack varies. The Chico cochineal is most destructive to the common pest pear, *O. inermis*, the Texas form favours the spiny pest pear, *O. stricta*, while the Arizona strain seems to be equally suited by either plant. These cochineals are being widely spread throughout Queensland and New South Wales. They are doing splendid service in many places, especially in dense pear in timbered areas, breaking up the plant masses and destroying old plants; but probably the most useful feature of their work is the manner in which they attack the young seedlings. The Indian cochineal, *D. indicus*, was introduced in 1913 by the Queensland Prickly-Pear Travelling Commission, and will exist on the smooth tree pear, *O. monacantha*, only, completely destroying large clumps of this plant in the space of a few months.

Of the plant-sucking bugs, several species of the genus Chelinidea have been acclimatised; *C. tabulata* has been liberated in many places and has increased at a very rapid rate in the field; in fact, in some localities,

millions must now be present from small numbers set free in the past two or three years. *C. vittiger* has also been released at various places.

Of the internal-feeding caterpillars, one species, *Melitara junctolineella*, has been readily acclimatised; about a million have been liberated, and it is now firmly established in several localities. These caterpillars are solitary in habit, and tunnel within the joints or pads of prickly-pear. A related insect is *Melitara prodenialis*, but the caterpillars are social in habit, a number feeding together within the pear pads; recently this species has been set free in the Westwood district, and promises to be especially useful as a pear destroyer.

One of the most recent of the Board's importations has been strikingly successful in so far as rapid increase is concerned. This insect is *Cactoblastis cactorum*, a social caterpillar allied to the Melitaras. Less than three thousand larvæ arrived from Argentine in May 1925, but the increase has been so great that in February and March 1926, nine months later, sufficient stocks had been raised to warrant the release of two and a half millions throughout the pear areas. These caterpillars are voracious feeders, and should the increase in the field be sustained at one-half the rate experienced in the cages, great destruction of pear should be brought about.

Many other insects are being bred and acclimatised, and the Board is continuing the introduction of new forms, believing that the control of prickly-pear by biological means can only be brought about by the combined attack of a variety of insects operating on the different parts of the plant.

Chemical and Physical Action at Surfaces.[1]

By Dr. ERIC K. RIDEAL.

THE subject of colloid chemistry is intimately associated with the properties and peculiarities of interfaces, of which those formed by liquids and solids are the most important. The difficulties met with in an exact study of reactions taking place in colloidal systems are greatly enhanced by their dispersity, and in addition the application of thermodynamic methods to the treatment of the two-dimensional interfacial phases becomes a problem of great complexity when these phases are subdivided and not plane but curved. For these reasons the increasing attention which is being devoted to surface phenomena is a development to be welcomed. As the late Lord Rayleigh first indicated, the properties of oil films on water studied by Miss Pockels give us valuable information on molecular magnitudes, a view which has been emphasised and amply confirmed by the able experiments of numerous investigators, notably Devaux, Langmuir and Adam.

An examination of the process of spreading of oil films and their conditions of equilibrium presents several features which can be compared with phenomena occurring in three-dimensional systems. If a crystal of myristic acid be placed upon the surface of water a process of surface solution occurs, molecules are torn off the edge of the crystal in contact with the water by hydration of their polar or hydrophilic groups and float on the surface as a two-dimensional vapour. This process of surface solution continues until the vapour attains, as measured by the fall in surface tension of the water, the critical 'vapour pressure' value necessary for conversion into a two-dimensional liquid, the so-called expanded film of Adam. The liquid undergoes further two-dimensional compression by continued surface solution from the crystal, and if the temperature be sufficiently low, the expanded film is converted into a condensed film which may be liquid or solid. If the temperature be high, no formation of a condensed film occurs but the film remains in the expanded state. Compression does not proceed indefinitely, for the substance possesses but a finite surface solubility at a constant temperature and a saturation equilibrium is attained.

[1] Based upon two lectures delivered at the Royal Institution on February 2 and 9.

Both the rate of spread, which in the case of a rapidly spreading acid, such as oleic acid, rarely exceeds a linear speed of 25 cm. per second, as well as the progress of surface saturation and the transformation of the two-dimensional vapour into the expanded and condensed states, can readily be followed by observing the changes in surface tension at different points on the water when a cylinder of the acid is plunged below the surface. In the case of the spreading of solid acids, the rate of surface solution is so slow that no pressure gradient exists in the expanding film, but for acids which spread quickly molecules go into solution so rapidly that those already on the surface are actually pushed out by those entering, causing a local lowering of the surface tension.

For the long-chain fatty acids the molecular adhesion by the hydrocarbon tails is so great that these two-dimensional films, even at high temperatures, are analogous to vapours rather than gases. Substances which can exist in a state equivalent to two-dimensional gases on a water surface over the ordinary experimental temperature range must possess chains less than eleven carbon atoms long; these are appreciably soluble in water and their surface concentrations must be calculated by means of the Gibbs Thomson equation. It is found that if the force-area curves calculated in this manner for substances such as the short-chain fatty acids or alcohols on the surface of water, or at interfaces such as benzene-water or mercury-water, be plotted, they reproduce in all respects the pressure volume curves obtained by Amagat for gases at high pressures.

Not only can we examine the behaviour of matter in its various states in this two-dimensional system, but a knowledge of the variation of the equilibrium pressures with the temperature, and the application of the Clapeyron equation, also yields values for the latent heats of 'spreading' of these substances. We may note in addition that the potential difference existing at the boundary between a homogeneous aqueous phase and its vapour is profoundly modified by the presence of such films. From a knowledge of the surface concentration and the change in potential effected by the presence of the film, the change in electric moment caused by the introduction of one molecule of the fatty

acid into the surface phase may be determined. If these be calculated for a number of organic substances, many interesting results are obtained: thus the electric moment of the fatty acids appears to reside entirely in the carboxyl group and is of a value equivalent to that produced by separating a proton and an electron to a distance of 0·06 Å.U. The moment of the alcoholic hydroxyl group is some twenty per cent. smaller. Very considerable changes in electric moment are caused by the introduction of the halogens or amino groups in place of hydrogen. Careful analysis of these changes may throw some light on the vexed question of polarity, which appears to be of some importance in organic chemistry.

The experimental examination of the behaviour of gases and vapours at solid surfaces is a much more difficult problem, for whereas a liquid surface is a surface of equipotential, it is almost impossible to obtain solid surfaces uniform in surface energy. Calculations from the compressibility of cubic heteropolar crystals, such as rock salt, of the surface energies of various planes, have been made by Born and more recently by Jones; the data, although admittedly only approximate in character, indicate enormous variations from face to face. Microscopic examination of the process of crystal growth, solution and etching, likewise support this conception of a variation in the forces of adhesion to crystal facets and edges. The change from a super-cooled liquid to a crystal may be regarded as resulting in a diminution in the potential energy of the surface as well as of the material in the interior.

These speculations lead us to the idea that the surface of a metal prepared, say, by the reduction of the oxide at low temperatures, is not a regular and uniform, if somewhat undulatory, checker board of equipotential points, but consists of portions of minute crystal edges, planes and corners in addition to numerous skeletal chains of atoms awaiting the opportunities provided by thermal agitation for slipping into a more compact crystal lattice. Both the interatomic distance, as well as the number and variety of atoms around one particular atom, affect the field of force which contributes to the adhesional potential energy of the surface. By a process of summation we may regard the surface as containing patches of varying activity on which substances are adsorbed but not with equal facility. Adsorption on a very active patch is associated with a large heat evolution and presumably also with a large decrease in the free energy of the system, and the patch may become saturated with gas before the less active patches are more than sparsely covered. This conception of a variation in the 'availability' of a surface, as an explanation for the experimental data indicating different saturation maxima for various gases and vapours, cannot, however, be considered a general one, for we find that many vapours, and possibly some gases, especially when near their critical points, may be adsorbed in layers more than one molecule thick. A difference in the amounts of two vapours adsorbed at saturation may be interpreted as due to a difference in film thickness.

Whilst the first or unimolecular layer is held on extremely firmly, the decrease in free energy resulting in building up the subsequent layers is but small; their formation may be regarded as due to an increase in the molecular cohesion of a molecule resulting on adsorption rather than a direct attraction of the surface for a molecule some distance away. As a convenient analogy we may cite the example of a weak magnet holding a string of iron filings. A second filing may be attached to the free end of one already hanging from the magnet, but if the first one be removed a filing will not be drawn towards the magnet from the position originally occupied by the second.

In catalytic actions also which appear to be limited in action to the primary adsorbed film, we find that those portions which are unstable and readily adsorb gases are also catalytically active. Since the measure of the catalytic efficiency of a metal is the rate of reaction, it is clear that a relatively large area of the active surface is required. A variation in the closeness of packing, as well as an introduction of foreign elements, frequently alters the rate of reaction. There appear to be at least three different types of such active surfaces on carefully prepared nickel: on one all hydrogenation reactions, including saturation of ring compounds, may be performed; on a less active area, simple double bonds undergo hydrogenation but not ring compounds; and a third area facilitates only the reduction of nitro groups. In the case of carbon containing both iron and nitrogen, there exists a large area, inactive catalytically, for the oxidation of oxalic acid; but in addition there exist areas of active carbon, active carbon-nitrogen, active carbon-nitrogen-iron and active carbon-iron complexes; these all possess different specific surface activities and different temperature coefficients for the reaction velocities. Since the products of reaction must leave the surface before new reactants can approach, it is possible that there is an upper as well as a lower limit to the strength of field on the surface which is most desirable for an efficient catalyst.

There has been a great deal of speculation, founded upon little experimental work, as to the nature of the union between substrate and adsorbate and the mechanism by which some of these complexes are rendered active. That complex organic molecules are attached by particular groups, usually the polar or lyophilic group, to metals and oxides can be demonstrated in a number of cases; the union, however, is not so intimate as in a true chemical compound of the heteropolar type, for a ready distinction in ease of reduction is to be noted in the case of films of copper or nickel oxide and films of oxygen adsorbed on the metals. Again, a few interesting observations scattered in the literature would lead us to conclude that there exists an intimate connexion between the catalytic activity of a metal and those electrons in the metal capable of being ejected in thermionic emission. Hydrogen and oxygen, it is stated, commence to combine rapidly on a platinum wire which has been heated to such a temperature that the rate of thermionic emission becomes sensible; also a tungsten wire poisoned with a suitable impurity neither effects catalysis nor emits thermions. Finally, the investigations of Richardson on the possibility of different rates of thermionic emission from different parts of a metal surface are suggestive in connexion with the concept of areas of different activities.

Whilst our present knowledge of the mode of adsorption and type of binding is very incomplete, our information on the mechanism of activation is still scantier. It is in many cases difficult to obtain a measure of the true energy of activation, not only on account of the possible variation in stability of these adsorption compounds with the nature of the surface, but also because the velocity of the reaction, from the variation of which with the temperature these energies are obtained, may be determined by some other factor than the excitation of the reactant. Apart from these additional complexities, the fundamental problem of the mechanism of molecular activation in simple uni-, and possibly also in the case of bimolecular gas reactions, cannot be said to have received a successful solution.

Almost a decade has passed since Langmuir published his most stimulating paper on surface action, which did much to renew interest in this field. An enormous volume of experimental work has been accomplished during this time and the complexities of the subject have undoubtedly increased. In spite of this it is as full of interest as it was in the time of Faraday, and whilst many of the problems unsolved then await solution now, our knowledge of the processes occurring at surfaces still continues to increase.

Obituary.

PROF. W. J. LEWIS, F.R.S.

THE sudden and unexpected death of Prof. W. J. Lewis deprives mineralogy of a well-known personality. He passed away peacefully in his sleep in the afternoon of April 16 at the house of his sister, Mrs. G. T. Pilcher, at Godalming, Surrey. William James Lewis, the second son of the Rev. John Lewis, was born at Llanwyddelan in Montgomeryshire on January 16, 1847, and was educated at Llanrwst Grammar School. Entering Jesus College, Oxford, as a scholar in 1865, he took first classes in Mathematical Moderations in 1867, in Mathematical Finals in 1868, and in Natural Science in 1869. He gained the Senior Mathematical Scholarship in 1871, and was elected a Fellow of Oriel College in 1872. Not being married, he held this fellowship until his death, and the funeral service was conducted in the chapel of Oriel College.

For a time (1870–71) Lewis was an assistant master at Cheltenham College, and in 1875 he became an assistant in the Mineralogical Department of the British Museum, which at that time was under the keepership of Prof. Story-Maskelyne in the old building at Bloomsbury. On account of his health he retired from this position in 1877, and was succeeded by Sir Lazarus Fletcher. At that time Lewis was ordered abroad and given only a year to live; but in spite of that he reached his eightieth year. He took the opportunity of joining two solar eclipse expeditions, making observations on the polarisation of the corona.

Lewis had studied crystallography under Prof. W. H. Miller at Cambridge in 1874, and in 1879 during Miller's illness he acted as his deputy. He took the Cambridge M.A. degree by incorporation in 1880, and since then had lived in rooms in Trinity College. In 1881 he was appointed professor of mineralogy in succession to Miller, who had held office since 1832. Between them they had thus held the chair for ninety-four years; and it seems to have been Lewis's ambition to beat the record created by Adam Sedgwick and McKenny Hughes, who had sat tightly in the Cambridge chair of geology for ninety-nine years. Fortunately, under the new regulations, this state of affairs cannot be repeated. The professorship of mineralogy, founded in 1808, had previously been held by E. D. Clarke, the botanist J. S. Henslow, and the celebrated William Whewell, Master of Trinity, and it has been closely connected with the development of the sciences of mineralogy and crystallography. The Millerian system of notation now in general use for the planes of crystals was conceived by Whewell and elaborated by Miller; and the crystallographic constants still accepted for many mineral-species were first published by Miller in his classical treatise on mineralogy. The Cambridge collection of minerals contains much material of historical value and interest, and it has been considerably added to by Lewis, notably by the acquisition of the Carne and the Wiltshire collections.

Lewis encouraged many more students than in the old days, and mineralogy soon became a popular Tripos subject taken in conjunction with geology. He was not a prolific author, the list of his original papers being limited to twenty-one titles, many of them only short notes. The earliest, in 1875, on the crystallography of some organic compounds, were published in the *Journal of the Chemical Society*, and others on the crystallography of various minerals (glaucodote, miargyrite, stephanite, albite, etc.) appeared in the *Philosophical Magazine* (and reprinted as the *Proceedings of the Crystallological Society*), the *Proceedings of the Cambridge Philosophical Society*, and the *Mineralogical Magazine*; some of them being also translated into German in the *Zeitschrift für Krystallographie und Mineralogie*. Lewis delighted in the intricacies and difficulties presented by twinned crystals, and in devising geometrical methods for dealing with the rhombohedral system of crystals. In later years the material described had been collected by himself during his many trips to the Binnenthal and other mineral localities in Switzerland. In 1919, at the age of seventy-two years, when alone in the Lengenbach quarry, he had the misfortune to slip and break his leg. There he lay in the snow all night, and in the morning he found a piece of wood to bind as a splint, thus enabling him to crawl out and fortunately attract attention.

The most important work written by Lewis was his "Treatise on Crystallography," published in 1899 in the series of Cambridge Manuals. In the preparation of this book he spared no pains, and it remains the best text-book on geometrical crystallography. He also wrote in 1913 a history of the parish of North Wraxhall in Wiltshire, which included a life of his friend Francis Harrison, the late rector.

Lewis acted as secretary of the Crystallological Society from its foundation in 1876 until its amalgamation with the Mineralogical Society in 1883, and was librarian of the Mineralogical Society since 1890 and president in 1909–12. He joined the Chemical Society

so long ago as 1869, the Royal Astronomical Society in 1873, and was elected a fellow of the Royal Society in 1909. To many Cambridge men he was well known as the director of the Cambridge University Scholastic Agency, which he founded as a private venture in 1884, long before the official Appointments Board; and in connexion with this he worked out an insurance scheme. L. J. S.

WE regret to announce the following deaths:

Sir Henry Christopher Mance, past president of the Institution of Electrical Engineers, on April 21, aged eighty-six years.

Admiral Sir John Franklin Parry, K.C.B., formerly Hydrographer of the Navy, and president in 1919 of the International Hydrographic Conference held in London, on April 21, aged sixty-two years.

News and Views.

IN our supplement this week Prof. Eddington deals with a subject which has become of the greatest importance in cosmic physics; namely, the source from which the stars derive the enormous quantities of energy which they radiate continuously into space. The character of this source and the manner in which it is tapped are fundamental questions which lie at the very heart of the problem of stellar evolution, for so long as they remain undetermined the problem cannot be solved. Indeed, the very idea that stars evolve at all is derived from the observation that they radiate more energy than they receive from extraneous sources. Internal energy, or its equivalent, must, therefore, be transformed into radiation, and the change in the star brought about by the transformation is its course of evolution. Historically, it is true, the problem has been attacked most strenuously by observing the actual course of the change, regardless of its origin, on the assumption that the statistical distribution of stars with respect to physical characteristics represents the history of a single star. This method of attack, however, so long as the fundamental problem of the source of stellar energy is ignored, can, by its very nature, lead to nothing more than a description of a process of which the mainspring is unknown; and it now appears doubtful whether even that degree of success has been attained, for our confidence in the identity of a star's course of development and the statistical curve has been rudely shaken. It is therefore a matter for satisfaction that we are at last in a position to deal with the problem radically, and Prof. Eddington's admirably impartial and penetrating discussion clears the ground for action.

THE one definite conclusion that emerges from the researches of Prof. Eddington and others is that if the history of a star follows the statistical curve, or any curve approximating to it, there must be a transformation of matter into radiation by annihilation of electrons and protons, unless current theories are hopelessly on the wrong track. The existence of such a transformation, revolutionary as it would have appeared a few years ago, has perhaps been accepted somewhat too readily, and Prof. Eddington very opportunely directs attention to some of the difficulties which it involves. It may, as he says, be possible to wriggle out of them, but it would be much more satisfactory if they released us of their own accord. It may be questioned, however, whether he has given sufficient weight to the physicist's objection to a critical stellar temperature of transformation; at any rate, the physicist is entitled to invite him to pursue his reply to its logical conclusion. Speaking of the less drastic change of hydrogen into helium as an example, he says: "But helium exists, and it is not much use for the critic to urge that the stars are not hot enough for its formation unless he is prepared to show us a *hotter place*." The critic might retort that protons and electrons also exist, and presumably were created, and if a critical temperature suffices for their destruction, it might also permit their creation. If that process also takes place in the stars, the whole problem takes on a different aspect. But whether occurring in the stars or elsewhere, the creation of matter can scarcely be ignored in a cosmology which gives a prime importance to its annihilation.

ON May 6 Prof. Sigmund Freud reaches his seventieth birthday, and the occasion is being celebrated by the International Psycho-Analytical Association, branches of which are now established throughout Europe, in the United States, and in India. A sum of money raised by the various constituent societies of the Association will be presented to Prof. Freud to be used by him in aid of some work or individual worker in the field of psycho-analysis, and a large number of his co-workers and associates from various countries will be present in Vienna on May 6 to take part in the commemoration. Further, there will be special articles in the two European journals devoted to the study of psycho-analysis—*Die Zeitschrift* and *Imago* (Vienna)—and also in *The International Journal of Psycho-Analysis* (London), written by intimates and co-workers of Freud. Almost synchronising with his birthday is a new development in London in the shape of the first Psycho-Analytic Clinic, to be established this month by the Institute of Psycho-Analysis, which will become, it is hoped, a worthy memorial to Freud's work and inspiration. In his own town of Vienna (Freud's actual birthplace was Freiburg, but since 1860 he has been associated with Vienna), of which he was made a freeman about two years ago, the municipal authority wished to make some public recognition of its great citizen, but Freud declined the honour. Indeed, it is characteristic of Freud that he has always refused to come personally into the limelight, no matter how far and wide the echoes of his work reverberate.

To scientific workers it is unnecessary to stress the significance of Freud's work: it will suffice to say

that whatever the future may reveal to modify his discoveries, through his work the whole outlook of psychology has been once and for all altered. Further, owing to this change, innumerable spheres of thought have been influenced and future investigators will utilise, knowingly or unknowingly, those discoveries in the realm of mind which are the outcome of Freud's genius aided by his life's unremitting labour. In accord with the continuous development of his thought, this year has seen the publication of a volume embodying his latest research on the important subject of anxiety: in "Angst, Hemmung, und Symptome," the problems of anxiety, inhibitions in relation to anxiety, and the creation of anxiety-neurosis are shown in fresh aspects. Freud himself has written that he does not know whether the developments from his work will be much or little, but that he has made many beginnings and has stimulated much thought and inquiry. The verdict of posterity will surely subscribe to his estimate save on the score of its modesty.

ON May 4 occurs the bicentenary of the birth of Major-General William Ray, a distinguished military engineer and one of the originators of the trigonometrical survey of Great Britain. Born in Lanarkshire and educated at Lanark Grammar School, at twenty years of age Ray entered the army and was immediately employed on road-making and map-making in Scotland. This was long before Telford's beneficent labours. Rising steadily in the service, Ray saw active service in Germany during 1759–63, and in 1765 became surveyor-general of the coasts and engineer for making military surveys of Great Britain. By 1783 he had become colonel of the Royal Engineers, and in the following year he measured the famous base on Hounslow Heath, 27,404 feet long. This work attracted much attention at the time, and the Royal Society awarded Ray the Copley Medal. From this base line the triangulation was carried down to the south coast, a verification base line of 28,535 feet being measured on Romsey Marsh, and on September 23, 1787, Ray met the French Commission which had carried the survey of France northward from Paris. With this work Cassini, Mechain and Legendre had been connected, the object being the determination of the relative positions of Greenwich and Paris observatories. Shortly after this Ray went to Lisbon for his health. He returned in April 1790, but died suddenly at his house in Argyll Street, London, on July 1, 1790, while engaged in correcting proofs of a paper for the Royal Society. Many of his maps are in the British Museum.

THE institution of experiments in the care of animals, which will be followed with much interest, are recorded in the "Reports of the Council and Auditors of the Zoological Society of London for 1925," presented at the annual meeting of the Society on Thursday, April 29. Observations on a limited scale have indicated that animals, especially natives of tropical climes, thrive better in the presence of radiant light and heat and in an atmosphere of cold fresh air associated with warmed shelves. Accordingly, the cave-shelters in the new rock-work enclosure behind the Mappin Terraces, which accommodate a troop of 80 Hamadryas baboons, have been fitted with wooden shelves warmed from below by electric radiators and lighted from above by quartz incandescent lamps, which are permeable to ultra-violet rays. Some of the outside rocky ledges have also been warmed electrically and lighted by quartz lamps which can be turned on to diffuse 'artificial sun-light' when the weather is dull. Similar fittings, which, for upwards of a year, have been tested with delicate monkeys, such as a young orang-utan and marmosets, in the full-size model of part of a proposed new Ape and Monkey House, have given most promising results. In furtherance of the same policy, an attempt has been made to utilise the full value of natural light by replacing the ordinary glass of the whole roof of the lion house by 'vitaglass,' which is permeable to the ultra-violet rays of the sun. The success of these experiments would cause a revolution in the lighting and heating of the shelters and cages in zoological gardens, and a much-needed amelioration in the living conditions of many tropical animals, which in most gardens and under the best conditions are subject to a heavy disease and death rate.

DR. H. J. ROSE delivered a lecture on "Prehistoric Greece and Mother-right" to the Folk-Lore Society on April 21. The lecture was an elaboration and extension in the light of further research of an article contributed by Dr. Rose to *Folk-Lore* in 1911, and a confirmation of his earlier conclusion that no evidence of mother-right existed in early Greece. Such possible sources of evidence as the well-known inscription at Kos, the Code of Gortyn, the two plays the "Suppliants" and the "Eumenides" of Æschylus, and the genealogies from the old historians and from Pausanias. which have been interpreted by many authorities as indicating a matrilinear system, were discussed in detail. The entries of the Kos inscription, which state specifically that the right to participate in the sacred rites was derived from the mother, are regarded by Dr. Rose as exceptional cases, probably due to the peculiar position occupied by heiresses under Greek law, and the stories of the Danaids and of Orestes and Clytemnestra as told by Æschylus were rejected as warranting an assumption of mother-right after a close consideration of the plays themselves. The genealogies were compared with the earlier traditions on which they were based, and were shown to be frequently at variance with them and not therefore wholly trustworthy as evidence. The paper is to be published in an early issue of *Folk-Lore*.

A LOST city of the Mayas in Yucatan is described in a further account of Dr. Gann's journey of exploration in Central America, which appeared in the *Morning Post* of April 19 and two succeeding days. A reference to a migration of the people of Chichen Itza eastward to "the settlement of the priest of Coba," in a recently translated portion of the Book

of Chilam Balaam, appeared to confirm information given to Stevens in 1842 and suggested a search in the neighbourhood of Chemax, an Indian settlement in the Chichen Itza region. The result was the discovery of a city of considerable size and at present unique in presenting three distinct types of Masa civilisation. The oldest style of Maya architecture is here represented by an enormous temple, stelae, and ranges of arched rooms. It is followed by the Tuluum type, represented by flat-roof, stucco-covered buildings. Last comes the Labaantum type—a great stairway similar to that discovered by Dr. Gann and Mr. Mitchell-Hodges during their expedition last year. In no other town have these three styles previously been found together. The city probably was founded about A.D. 926. Although it was occupied throughout the Toltec domination, it nowhere shows the influence of that people. A remarkable structure discovered on the road to Coba was a raised causeway, 32 ft. wide, and said by Dr. Gann's native guide to be fifty miles long. It was built of limestone rubble, and had been cemented on the surface. Dr. Gann is of the opinion that it must have been a sacred way for ceremonial use from Chichen Itza to Coba. Nothing like it is known elsewhere in Maya culture.

AT the meeting of the Circle of Scientific, Technical and Trade Journalists on April 19, Mr. J. G. Pearce opened a discussion on "A Clearing House for Information: its Value to Science and Industry, and its relation to the Press." Mr. Pearce gave an account of the work of the Association of Special Libraries and Information Bureaux, with which he is prominently associated. He remarked on two main characteristics of these times: the vast increase in the amount of "fact-information" available, as a consequence of scientific and industrial research, and the greater appetite for such information on the part of the general public. The press fulfils a most useful function in making such information known, but much of it is stored away and unknown to those in need of it. On the Continent efforts have been made to initiate vast schemes of filing and tabulating all available information. But such methods, though admirable as repositories for the future historian, are too complicated for everyday use. He therefore advocated the establishment of information bureaux and the setting up of a "clearing house" which would prepare a directory of sources of information in Great Britain. In the course of the discussion a letter from Mr. Bradford, the Director of the Science Library, South Kensington, was read. He referred to the unique resources of this Library and the tabulation of foreign bibliographies which is being undertaken, and suggested that a simple extension of its organisation would suffice to convert the Science Library into a general bureau of information. There was an interesting discussion, and general agreement was expressed with the principle of linking up existing libraries and rendering their contents better known. To the technical journalist, any steps likely to make such information more readily accessible will be of special value.

ANY misgivings as to the nature and effect of the restoration work on the Sphinx carried out by Mr. Baraize under the Egyptian Department of Antiquities during the past winter should be allayed by the detailed account given by the Cairo correspondent of the *Times* in the issue of April 23. There is no doubt that the work was urgently necessary. It would appear that the head was in an exceedingly bad condition. Huge cracks and cavities had appeared in the head-dress, part of which, together with the back of the neck, had been completely eroded. In fact, there was danger that the head might topple forward. There was also a deep gash on the left side of the head. All these cracks have been filled in, masonry has been built on to the back of the neck to preserve the centre of gravity, and two pieces of the head-dress found on the ground have been replaced. A hole in the head, which might have been made anciently by treasure hunters, and is large enough to take a man standing erect, has now been fitted with an iron cover. The clearing away of the sand, which had silted up to the shoulders, has revealed the serious extent of the erosion caused by wind-blown sand, after the limestone casing repaired by Tothmes IV. and the Ptolemies had been removed for building purposes. In contrast, the stonework now uncovered has all the appearance of being new. An interesting result which has emerged owing to the work of restoration, is the confirmation of the story that the monument was repaired by Tothmes IV. The striking lack of proportion between the head, the body and the paws has also been revealed.

PROF. R. WHIDDINGTON in his Friday evening discourse at the Royal Institution on "The Luminous Discharge through Rare Gases," delivered on April 23, stated that it has been known for a long time that when a gas in a glass tube is reduced in pressure, a stage arrives when an electric current can be passed with comparative ease along the length of the tube. One of the most striking effects of the current is the luminosity it produces in the gas. The tube becomes a source of light, just as the filament of an electric lamp does when the current passes through it. There is this fundamental difference, however, between the two cases. In the electric lamp filament the current is regarded as being carried wholly by electrons which, in threading their way through the closely packed and practically immobile atoms of the metal filament, produce the heat which raise it to incandescence. In the case of the gas in the discharge tube, the atoms are free to move as well as the electrons, which involves (*a*) that the atoms, when bombarded by the current-carrying electrons, frequently lose electrons themselves, becoming ions, and therefore assist in carrying the current by moving in a direction opposite to that of the electrons; (*b*) the gas in the tube emits light of a definite set of colours characteristic of the gas. In the case of the rare gases (argon and neon have been examined so far) new effects have been observed and interpreted. If a tube containing neon is viewed in a rotating mirror, it will be observed to be crossed by two sets of dark bands. The very broad sets are

due to the alternating nature of the electric supply, but the very narrow bands are due to the mechanism of conduction of the current by ions and electrons.

As part of his course of lectures on "Organs of Multiple Function" delivered at the Royal Institution, Prof. J. Barcroft on April 21 dealt with the spleen. Of all the bulky organs of the body the function of this alone has not been fully elucidated. The ancients are alleged to have improved the athletic potentiality of their runners by cutting this organ completely out, their argument being that the spleen was the seat of that unpleasant sensation, the stitch; but this does not appear to be justified by the records. Later it became associated with testiness of character. It is nowadays sometimes excised without fatal or even very distressing effects. Thomas Gray expressed his view of the spleen as being for the purpose of regulating the quantity and quality of the blood. Within this phrase can be grouped a multitude of functions. We may address ourselves to two: one affecting the quality and the other the quantity. The spleen is a muscular bag which when it distends becomes engorged with blood; yet this blood is not ordinary blood. For the spleen is also a sieve, at least functionally, and it appears to sift out and fill itself with red corpuscles of a certain kind. The variety selected is that which is reputed to be the oldest, and is most easily broken down by exposure to reagents, such as dilute salt solution. These corpuscles appear in many cases to die in the spleen, so that the spleen has become the reputed cemetery of red corpuscles. As regards quantity, in many animals the extent to which the spleen can absorb blood is such that a considerable proportion of all the blood in the body can be held by the spleen. When the body needs blood the spleen empties itself into the general circulation. This is the case when exercise is taken, when the animal is slowly poisoned with coal-gas or if the animal loses blood by hæmorrhage. On the other hand, if unnecessary quantities of blood are in circulation, the spleen dilates and blood is withdrawn. Such would appear to happen when undue strain is put on the heart.

EDUCATION and research in forestry continue to make good progress at Oxford. The Imperial Forestry Institute started work in October 1924; and its first annual report has just been issued by the Director, Prof. R. S. Troup. Advanced courses of instruction in the ordinary forestry subjects were given by the Director and eleven lecturers, of whom two, a silviculturist and an entomologist, are attached to the Institute by the Forestry Commission. The students, 22 in all, included 11 post-graduate probationers for the British and Colonial Forest Services, 8 forest officers on leave from the Colonies and India, and 3 students doing special work on the structure and properties of wood. A special feature in the training was the practical instruction given on the Continent for the purpose of studying the latest developments in silvicultural systems, forest management and exploitation. Some of the Colonial students studied systematic botany at Kew. The staff of the Institute was fully occupied during the year in giving courses of instruction, in procuring equipment and material for study and in other preliminary duties, and had no opportunity for research work; but this will be prosecuted when the Institute is in full working order. At the School of Forestry, Oxford, 32 students attended during the academic year 1924–25 the usual courses of instruction for the Degree and Diploma in Forestry.

IN his inaugural address on April 20, Prof. Lelean, the newly appointed professor of public health in the University of Edinburgh, said that it is a hard doctrine for individuals that the grown-ups of every generation have already had their day. But it is a worse doctrine for the race that 95 per cent. of the available funds should be spent in tinkering with the present C3-ridden generation while only 5 per cent. is expended upon the evolution of a new generation so fit that it can defy disease. Expectant mothers and growing children should be placed under conditions so physiologically favourable that the next generation will be overwhelmingly A1. He urged the elimination of non-essentials in education, and stated that some at least of the younger children are being pressed beyond their mental powers, and that a large proportion of the older children, especially in the better-class day schools, are being seriously overworked—the result of too high examination standards and overloaded curricula. He advocated a lowering of the present examination standards and education curricula, a reduction in the amount of home work, and a seat for some physiological expert—preferably the school medical officer—on every education committee in Great Britain.

THE first conversazione this year of the Royal Society will be held on Wednesday, May 12, at 8.30 o'clock.

SIR NAPIER SHAW, honorary member of the International Meteorological Committee, has been elected an honorary member of the Norwegian Academy of Sciences, Oslo, in the Class for Mathematics and Natural Science.

THE tenth lecture of the series, "Physics in Industry," being given under the auspices of the Institute of Physics, will be delivered by Mr. H. E. Wimperis, Director of Scientific Research, Air Ministry, who will take as his subject, "The Relationship of Physics to Aeronautical Research." The lecture, which will be open to the public, will be given in the Physics Theatre, Royal College of Science, Imperial Institute Road, South Kensington, S.W.7, on Tuesday, May 11, at 5.30 P.M.

IN our issue of December 26, 1925, p. 935, Prof. R. A. Sampson, President of the International Time Commission, announced that a new series of wireless time signals issued by the International Time Bureau at Paris would be in operation from the stations Eiffel Tower (FL) and Lafayette, Bordeaux (LY), from January 1 until April 30. It has now been decided to continue them as at present for a further period. Notice will be given when a change is made.

THE Society for Experimental Biology held its spring meeting at the Marine Biological Laboratory, Plymouth, on April 17 and 18. The programme included a symposium on the regulation of the environment and its effect on plants and animals, by Messrs. J. T. Saunders, W. H. Pearsall, and B. W. Keen, dealing respectively with marine and fresh-water plankton and soil organisms and conditions. Dr. F. S. Russell contributed a paper on the factors affecting the vertical distribution of plankton, and Dr. E. M. Delf and Mr. A. D. Cotton discussed certain aspects of the ecology of marine algæ. There were numerous exhibits, as well as further papers on ciliary control, muscle contractility, and the œstrus cycle. About eighty attended the meeting, which included excursions to Cawsand and concluded with a dinner.

BY an Order of the Committee of Privy Council, Lieut.-General Sir William B. Leishman, director-general, Army Medical Services, has been appointed a member of the Medical Research Council. The vacancy thus filled was consequent upon the recent approval of amendments to the Royal Charter of the Medical Research Council, which provide *inter alia* for an increase in the number of members from ten to eleven. Under the amended charter, two of the eight scientific members will retire in each year, and one of the three other members in each second year, the scientific members being not eligible for re-appointment before the end of one year after retirement.

THE Minister of Health will open the new laboratories of the Pharmaceutical Society of Great Britain on Wednesday, May 5. These laboratories were established by the Society for the testing of those therapeutic substances which will be scheduled under the Therapeutic Substances Act 1925. They comprise among other substances such important medicinal agents as digitalis, strophanthus, ergot and pituitary extract, the purity and potency of which cannot adequately be determined by chemical means. The laboratories are being carried on under the direction of the council of the Society with the assistance of an advisory committee, including among others Sir Humphry Rolleston, Sir Nestor Tirard, Dr. H. H. Dale, and Prof. W. E. Dixon of Cambridge. Dr. J. H. Burn has been appointed director of the new laboratories, and it is intended that pharmacological research should be carried on in addition to the routine testing of therapeutic substances.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—An assistant lecturer in mechanical engineering at the Brighton Technical College—The Secretary, Education Offices, Old Steine, Brighton (May 26). A professor of physiology at the Royal College of Surgeons in Ireland—The Registrar of the College, Dublin (May 28). Part-time lecturers in public health, and forensic medicine and toxicology, in the University of Bristol—The Registrar (May 30). A principal of the County Technical School, Stafford (candidates to be engineers) — The Director of Education, County Education Offices, Stafford (May 31). A head of the engineering department of the County Technical College, Wednesbury, and county lecturer in engineering for South Staffordshire—The Director of Education, County Education Offices, Stafford (May 31). A chemist at the Aeronautical Inspection Department Test House, Kidbrooke, S.E.—The Secretary, Air Ministry, Adastral House, Kingsway, W.C.2. A temporary metallurgist under the Directorate of Metallurgical Research, Research Department, Woolwich—The Chief Superintendent, Research Department, Woolwich, S.E.18.

Our Astronomical Column.

FIREBALL ON APRIL 9.—Mr. W. F. Denning writes that a brilliant fireball was observed passing over the east of England on April 9 at 11.30 P.M. G.M.T. It was seen from various places in the eastern counties and so far north as Westgate, Durham, but the late hour at which the object appeared must have greatly limited the number of its observers. The meteor was of remarkable brilliancy, for it vividly illuminated the country-side, and its sudden apparition on a moonless night was of somewhat startling character. It moved slowly and the nucleus threw off a number of red sparks, but the duration of flight did not exceed five seconds according to the careful estimate of a spectator near Harwich.

The radiant point appears to have been in Virgo, at 208° − 11°, and the height of the object declined from 71 to 42 miles during a path of about 71 miles with a velocity of 15 miles per second. The meteor passed from over the south part of Essex to north of Norfolk, its motion being directed from S. by E. The radiant in Virgo is that of a well-known April shower which has been frequently recognised in past years, and particularly on about April 8.

RELATIVITY SHIFT OF SOLAR SPECTRUM LINES.—In the *Proceedings of the National Academy of Sciences*, vol. 12, No. 2, Dr. C. E. St. John, of the Mount Wilson Observatory, makes a further contribution to the problem of the relativity shift of the solar spectrum lines. In a study of 331 iron lines, he finds a general displacement to the red, as required by the theory of relativity, but the amount of the displacement agrees with the theoretical value only for the lines of moderate intensity. Strong lines are displaced about 50 per cent. too much, and weak lines about 30 per cent. too little. The explanation offered is based on the assumption that the deviations from theory are connected, not directly with intensities but with the levels in the sun's atmosphere at which the lines originate, these levels being indicated by the intensities. The observations can then be accounted for in terms of three disturbing influences: (1) The relativity displacement, affecting all lines in all parts of the sun; (2) radial movements of the atmospheric gases, downwards at very high and upwards at very low levels; these produce a maximum effect at the centre of the disc and no effect at all at the limb; (3) differential scattering, tending to widen the lines at the red edges, and producing a much greater effect at the limb than at the centre of the disc because of the greater depth of atmosphere traversed. The last-named influence is held to account for the so-called 'limb-effect,' which has long been known.

Research Items.

PREHISTORIC DISCOVERIES AT PRESTATYN.—Some interesting evidence bearing upon the possibility of the survival of a palæolithic people in Wales into the Neolithic and Bronze and even into the Iron Ages has been obtained from excavations carried out during the last two and a half years in the neighbourhood of Prestatyn. According to a recent lecture by Mr. F. Gilbert Smith, delivered under the auspices of the Dyserth and District Field Club, the 'Byrn Newydd' people began to settle in that area after the last phase of the Ice Age. The original site of occupation is directly on the boulder clay, now from one and a half to five feet below the present surface level. The implement-bearing zone begins at a depth of about one foot. Of three mounds or islands in a basin of boulder clay, one, the smallest, which had been used as a workshop, had been sealed, after its abandonment, by a deposit of two feet of tufa, and had thus remained untouched by the influence of later cultures. The implements found here included a large number of typical Tardenoisian form with battered backs and cores. They are of chert of exceptional quality, and are worked with great skill. Conclusive evidence for the contact between this culture of epipalæolithic type and that of a later phase is furnished by the discovery of a flint spear-head and a polished stone celt in a 'fire-place' on one of the larger islands in association with artefacts, in the main of the type found in the workshop.

MAGIC IN MADEIRA.—Mr. James Hornell has recently made a study of superstitions connected with the evil eye in Madeira, and has published in the *Journal of the Royal Anthropological Institute*, Vol. 55, Pt. 2, an account of those in which the horns of various animals or substitutes therefor are used to avert evil. There is little overt evidence of this use, and indeed it was denied except in the case of protecting pigs against "bad air." Further inquiry showed, however, that the horns were used in several different ways. In fishing-boats they are employed as amulets against envy or the evil eye, but great secrecy about them is preserved, and they are kept in lockers under the decking. They are only mounted on the prow as a general observance when returning home on the popular festival of May 1—a pagan, not a religious festival. Horns are also used, but rarely, to protect crops. Though horns are not placed outside a house or over the door, the owner's possessions are protected by keeping a pair inside. The horns of a black goat or sheep are held to be the most efficacious. The familiar sign of the horns made with the hand is used and the amulet itself and its name are employed as a deadly insult to a married man, imputing infidelity on the part of his wife. It is probable that the use of an amulet in the form of horns is to be traced to a devil cult, the special efficacy of the goats' horns being significant in view of the belief that the devil when presiding over the witches' assemblies normally took the form of a horned goat. Further, it is to be noted that the amulet should be black.

FŒTAL OSSIFICATION.—The economic conditions which existed in Switzerland during the later years of the War gave Messrs. Kupfer and Schinz opportunities of collecting in slaughterhouses a series of specimens which illustrate every stage in the development and growth of fœtal calves ("Beiträge zur Kenntnis der Skelettbildung bei domestizierten Saugetieren auf Grund röntgenologischer Untersuchungen." Von M. Kupfer und H. R. Schinz. Denkschriften der Schweizerischen Naturforschenden Gesellschaft. Band 69.) Every stage has been X-rayed, and complete records made of the sequence in which the centres of ossification make their appearance in the bones of the limbs. The results of this investigation are graphically summed up in 68 text figures, while 26 photographic plates set out very clearly some of the data on which conclusions are based. These conclusions are that in spite of the dissimilar purposes served by the limbs of the ox and of man, yet the number of centres of ossification which appear in the limbs of each is the same, and the order in which these centres appear is also the same. In the limbs of the calf all centres have appeared by the time of birth, whereas in man their appearance is extended until the age of puberty is reached. The authors also discuss the laws of ossification as revealed by their studies; their conclusions are in agreement with those which have been formulated by anatomists for the centres of the human body. Besides observing centres of ossification, the authors of this monograph have reinvestigated the cartilaginous skeleton which is laid down in the limbs of the fœtal calf. The shaft of the fibula, after being laid down in cartilage, disappears, all save its extremities, which become ossified and persist. The digits corresponding to man's great toe and thumb have no embryological representation at any stage, but those which correspond to man's second and fifth digits are formed in cartilage and afterwards undergo atrophy. Thus it will be seen that this monograph contains much new and exact information and should be accessible to all who are investigating skeletal problems. Fortunately for the progress of knowledge, the authors were able to publish their results through subventions placed at their disposal by societies in Zürich.

EXPECTATION OF LIFE.—It is well known that the expectation of life at birth, *i.e.* the average duration of life, has considerably increased during the last thirty years; for males in London from 41·2 years to 53·8 years. This has been brought about chiefly by a falling death-rate in infancy and the early years of life. It is not so well appreciated that the expectation of life of the elderly has not correspondingly increased during this period. This fact is discussed by Prof. Raymond Pearl (*Natural History*, vol. 26, 1926, p. 26), who finds that the evidence available does not indicate that any increase is occurring now, or has occurred, in the recorded expectation of life of persons who live to the age of 75 years or more. Still less is there any evidence that the biological upper limit of the human life span has been raised.

MARINE BIOLOGICAL RESEARCH.—The recent issue of the *Journal of the Marine Biological Association* illustrates the general interest at the present day in the basal conditions of the environment in relation to the living organism, conditions which are at the root of economic research. The marine laboratories are naturally concerned with water-living organisms, and there are records of work by Atkins on the silica content of water, by Orr and Harvey on the nitrite and nitrate contents respectively, and by Poole and Atkins on the penetration of light into sea water. For the latter a new apparatus, consisting of photometers and photo-electric cells, is described. The other authors also bring forward improvements in technique, but much further research on this side is necessary, especially for the quick estimation of combined nitrogen. The greater concentration of the latter in deeper water is what is to be expected, as the phytoplankton necessarily uses up the combined nitrogen,

the organic proteins thus formed being afterwards broken down to simple compounds giving determinate cycles analogous to phosphates, etc. Of other matter, Russell's pelagic young of fishes is the second half of a research dealing with the vertical distribution of the macroplankton off Plymouth; it has a tentative list of distribution types, but we prefer to regard this work as preliminary to a deeper and more continued investigation. Miss Lebour completes the life histories of the Euphausidæ of the English Channel, the elucidation of which was of importance, as they are fed on largely by herring, hake, and other fishes. Dr. Amemiya records salinity experiments on the development stages of oysters. Lastly, the work of Fox on lunar periodicity in reproduction is confirmed by Orton in oysters, the normal forms in 1925 showing "three maximal percentages in spawn in the weeks after the July, August and September full moons."

FREQUENCY CURVES IN HERRING INVESTIGATIONS.—In his report of "Norwegian Fishery and Marine Investigations," Vol. III, No. 4, Dr. Einar Lea has given an important reply to Miss Catherine W. M. Sherriff's report on her mathematical analysis of random samples of herrings ("Fisheries, Scotland," Sci. Invest., 1922). Miss Sherriff was able to show that some of the empirical curves of frequency for the length of fish and for the number of rings counted on the scales, could be very well represented by one or other of the theoretical curves of variation, while others which were bimodal could be represented by the addition of two such curves. Prof. d'Arcy W. Thompson wrote an introductory note to Miss Sherriff's report, and it is the import of this note, rather than the results obtained by Miss Sherriff, which has attracted Einar Lea's attention. Lea infers that Prof. d'Arcy Thompson considers the conformity between the empirical curves of frequency and the theoretical curves of variation to be a criterion in deciding whether a sample of herrings contains a single year group or several. Mathematicians will follow with interest the argument by which Lea comes to the conclusion that empirical curves of frequency, of which the similarity to theoretical curves of probability or variation cannot be doubted, may arise from and represent processes which have nothing to do with variation and variability in the sense given to these terms by Prof. d'Arcy Thompson. The curve of frequency for the length of the herrings in a random sample may easily show sufficient degree of similarity to a theoretical curve of variation even though the individuals in the sample belong to several age groups, and the curve of frequency for the number of rings on the scales may also have a form which is so like a theoretical curve of variation that it might be mistaken for one, without this fact arguing against the assumption that the rings are annual rings; and that consequently the curve of frequency represents the distribution of age in the shoal from which the sample comes.

INFLUENCE OF TEMPERATURE ON THE LOCUST.—In the *Bulletin of Entomological Research* for March 1926, Prof. V. P. Pospelov describes some experiments showing that temperature during breeding exercises great influence on the development of the locust (*Locusta migratoria* L.) There is a certain limit of favourable temperature below which development of the genital products in the imagines ceases and the insects easily succumb to bacterial diseases. Young insects kept at a temperature of 35°-38° C. and with humidity near the saturation point developed rapidly, became adults, and commenced oviposition. In a second experiment, insects during their first two instars were kept under these same conditions. When in the third instar, they were transferred to a temperature of 30° C. by day and 20° C. by night with humidity at about 70 per cent.; they became sluggish, ate very little, and those which ultimately became adult failed to mature sexually and died without laying eggs. Observations were also carried out with reference to the occurrence of *Coccobacillus acridiorum* in the blood, and the results obtained confirmed the opinion of Mereshkovsky that this organism is a normal symbiont of locusts, but becomes a parasite under unfavourable conditions of temperature and humidity.

PLANT COLONISATION OF THE SEA-SHORE.—Prof. F. W. Oliver has an interesting account of the spread of *Spartina Townsendii* in the Seine estuary, between Havre and Tancarville, in the *Gardener's Chronicle* for March 20. Unlike the process of colonisation in Poole Harbour, where Spartina follows upon Zostera, on the Seine Spartina is settling upon virgin ground. As Spartina appears to have been unknown in the Havre district ten years ago, the advance made by the plant since is a very striking example of its powers of rapid colonisation. A further striking point is that in various local patches Prof. Oliver seems to find clear evidence that Spartina, the coloniser, has in its turn been ousted and replaced by *Glyceria maritima*. The species is unusually luxuriant in its growth and is apparently particularly favoured by some of the local habitat conditions. In *Modern Science* for April 1926 Prof. Mangham of Southampton discusses another sea-shore coloniser, *Sueda fruticosa*, an almost evergreen, tough, woody shrub, which he suggests might be tried out as a practical method of delaying or arresting the inward movement of mobile shingle banks in various seacoast areas.

NATURAL WOUND HEALING IN TREES.—Mr. T. Swarbrick has a paper on this subject in the *Journal of Pomology and Horticultural Science* (vol. 5, No. 2, March 1926). The outstanding result is that in all the species of trees examined (in a Yorkshire area), study of the natural processes involved in healing showed that, if the wounds were made during the months May to August inclusive, they were soon blocked against the entry of disease organisms; on the other hand, wounds made in September and October may block partially, and wounds made during November to April, scarcely at all, as the result of natural changes at the cut surface. Anatomical and micro-chemical details are supplied as to the nature of this process of blocking, which is mainly due to a gradual plugging of vessels and tracheids by 'wound gum' secreted from the starch containing cells in the neighbourhood of the cut. Such blocking is much more rapid than any subsequent healing by the inward growth of callus tissue from the periphery of the cut stump. These data would seem to be of interest in connexion with the practical operations of pruning, etc., by which cut surface of woody branches are exposed to the entry of disease organisms at various seasons.

MYCORHIZA.—Dr. M. C. Rayner has commenced in the *New Phytologist* (vol. 25, No. 1, 1926) a monographic account of this subject which will be of very great value to botanical workers. The literature of the subject, whilst very extensive, is so very scattered, the problem of association of fungus and flowering plant being capable of attack from so many points of view, that as a result the subject certainly lacks adequate presentation in modern text-books, and there is no doubt that an impetus to the study of a widespread phenomenon should be the result of this publication. Dr. Rayner's first instalment of this

study, with its account of Kamienski's pioneer work upon Monotropa, its full analysis of the classic researches of Frank, with its quotation from the original papers and reproductions of some of the figures published by these earlier authors, certainly provides most botanists with a sounder basis upon which to commence its examination than could be readily provided otherwise save by long searching through the literature. It was also a happy idea to quote again de Bary's original definition of symbiosis, in view of the long controversy as to the relative value to flowering plant and fungus of their close relationship. De Bary, as Dr. Rayner points out, clearly intended symbiosis to include all cases of mutual relationship in life of two organisms, including parasitism.

RECORDS OF PLANTS.—The *Kew Bulletin* No. 2 for 1926 contains some very good photographs of the remarkable tree *Clistoyucca arborescens* Trelease, which grows in 'forests' in the Mohave desert, Los Angeles, California; it is separated from the genus Yucca mainly on account of the very thick perianth segments and the absence of a style. C. E. Hubbard gives the full taxonomy of a useful fodder grass, *Paspalum Larranagai* Arech., "Vasey grass," a native of South America; it has now been introduced into North America and South Africa. L. A. M. Riley supplies notes on the flora of Rapa Island, visited by the *St. George* during the Pacific Expedition, 1924–5. Rapa is 250 miles to the S.E. of the Australs, and of the seventeen species collected there, four are apparently new to science. Under the heading "Spolia Mentawiensia," Mr. C. Boden Kloss states that it is proposed to give an account of the results, mainly zoological and to be published in various journals, which were obtained by a collecting expedition in 1924 in the Mentawi group of islands to the west of Sumatra. A beginning is made by an account of the flora by Mr. H. W. Ridley. Mr. W. B. Turrill has some notes on the flora of the nearer East in the same number of the journal.

MAGNETIC OBSERVATIONS.—The March issue of the *Journal of the Washington Academy of Sciences*, 16, p. 109, 1926, contains an interesting lecture on "The Magnetic and Electric Survey of the Earth, its Physical and Cosmical Bearings and Development," by J. A. Fleming, of the Department of Terrestrial Magnetism, Washington. The lecture sketches very briefly the historical development of terrestrial magnetic and electric observation up to its present extensive and detailed though still incomplete stage. There are now about fifty active magnetic observatories, of which less than 20 per cent. carry on electric work; 40 per cent. are in Europe, and less than 20 per cent. in the southern hemisphere. The polar regions are naturally very scantily supplied, a most regrettable fact in view of the interest and importance of the auroral and magnetic phenomena which there attain special intensity. As regards the general magnetic field, even in well-surveyed regions magnetic observations must be continually repeated at regular intervals in order to keep the magnetic charts up-to-date, on account of the rapid and incalculable secular variations in the earth's field: these changes are complicated even over the deep sea.

COLORIMETRY.—A considerable portion of part 2 of volume 27 of the *Transactions of the Optical Society* is devoted to the methods of specifying and matching colours, and Mr. J. Guild, of the National Physical Laboratory, adds considerably to our knowledge of the theory and technique of the subject by his three papers. The standard method of specifying a colour is by the amount of each of three chosen 'primary colours' which, when mixed together, match the given colour. Mr. Guild points out that so long as the three primary colours produce white when properly mixed, no special significance attaches to the particular colours chosen, but for convenience he uses a red of wave-length 63×10^{-6} cm. obtained by a Wratten No. 71 filter, for the green a wave-length about 54×10^{-6} cm. obtained by a Wratten No. 62, and for the blue a wave-length 45×10^{-6} cm. by a Wratten No. 49 B filter. For colours of high spectral saturation which are not conveniently dealt with by the trichromatic instruments, Mr. Guild has devised a monochromatic plus white colorimeter which retains the advantage of using spectral colours.

COLOUR KINEMATOGRAPH FILMS.—The method of producing colour kinematograph films by the 'Technicolor' process was described by Mr. Leslie Eveleigh at the Royal Photographic Society on March 30 (*British Journal of Photography*, April 9, p. 215). It is a two-colour process, using standard film, and the pictures are projected by the usual standard apparatus. The colour records are taken alternately by means of a camera that has a prism light-divider behind the lens with an orange-red filter for one and blue-green filter for the other, the two images being foot to foot, that is, the images of one colour being erect, while those of the other colour are upside down. A specially exact perforating machine has to be used to ensure a sufficiently perfect registration of the subsequently superimposed pictures. In printing, the negative is shifted two spaces and the positive one, so that only the red sensation pictures are printed, and then, on another film, the blue-sensation pictures are similarly printed. The two positives, before development, are brought back to back, the cementing liquid is sprayed on to them, and by pressure they are firmly cemented together. The compound film is then developed, washed, dried to a tacky condition, and passed over the surfaces of the necessary dye solutions, first one surface being dyed red and then the other surface dyed blue. Excess of the dye solutions is removed by suction, and when dry, both sides are sprayed with varnish, and the protection so afforded is so complete that the final film may be soaked in water for even two hours without damage. The cost is about 3*d*. a foot, while the ordinary monochrome film costs 1¼*d*. a foot.

'CREEP' IN METALS.—Two communications to the recent meeting of the Institute of Metals deal with the subject of 'creep.' R. W. Bailey, from an examination of data obtained by several different investigators, comes to the conclusion that for most, if not all, metals the relation between the time t taken to produce a specified softening of the cold-worked metal and the temperature θ at which it occurs has the form $t = t_0 e^{-b\theta}$, b being of the order of 0·05 for a variety of metals. It is independent of the condition of the metal, but t_0 varies with the condition. The results suggest that creep should not occur under stresses below the elastic limit. H. J. Tapsell and J. Bradley, experimenting with a 70 : 30 nickel-copper alloy containing 2·35 per cent. of manganese, find that this alloy, whilst inferior to an alloy of nickel and chromium, gives very satisfactory results of mechanical tests at high temperatures. The limiting stress which will produce creep is in these experiments much above the elastic limit, except at high temperatures, but it is of course very difficult to decide whether creep is actually occurring when its amount is small, and experiments may measure rather the accuracy of the apparatus used than the true limiting stress. The alloy gives good impact tests even at 700° C.

Proceedings of the Optical Convention, 1926.

THE exhibition of instruments associated with the Optical Convention having been described in our issue of April 24, while the very entertaining optical illusions arranged by Sir Richard Paget and Dr. R. S. Clay were fully noticed in the lay press, the present article will be devoted to a brief review of some of the papers read during the daily sessions, which occupied two lecture-theatres at the Imperial College of Science and Technology, South Kensington, throughout the week of the Convention. As there were nearly a hundred papers in all, it is impossible to refer here to more than a few of them, but it is understood that the Proceedings of the Convention, containing the complete text, will be published in time to be available at the Oxford meeting of the British Association.

The contribution of outstanding merit was undoubtedly Mr. J. Guild's "Survey of Modern Developments in Colorimetry," and the discussion of this and other topics was enhanced in interest by the presence of Mr. H. E. Ives, of the United States, to whose labours the science of optics is so much indebted. There are few subjects upon which text-book information lags so far behind the available knowledge as the investigation of colour, and it would be difficult to exaggerate the value of this report, which is not less remarkable for its lucidity than for the directness with which it selects for discussion topics which are of greatest practical interest. It was news to many who might be expected to know about such things that the photometry of colours has been put upon such a basis that "the luminosities of different coloured lights can be equated to one another, or added together, in exactly the same way as a gallon of oil can be equated, on a volumetric scale, to a gallon of water, and as the total volume of a gallon of oil added to a gallon of water will measure two gallons."

Various criteria for equality of brightness have been examined, and it has been found that the difficulty which is experienced in judging the equality in brightness of two dissimilarly coloured lights is due to adventitious psychological factors which can be eliminated by statistical methods. Simple photometry therefore provides the basis of the modern theory, but flicker photometry can also be used as a derivative method of comparison. The paper deals very thoroughly both with the underlying theory and with the practical methods of colour measurement and specification, and shows that the whole subject is now upon the level of an exact science: colour mixtures can be specified numerically with precision. The terminology is still somewhat confused, however, and the Optical Society, following the example of the corresponding American body, is seeking information by means of a questionnaire with the view of standardising the nomenclature. The author considers that the most pressing need of the science is a statistical standardisation of the chromatic properties of the normal eye: the laws of colour mixture are subject to fluctuations, being slightly different for different individuals, and systematic experiment is necessary to ascertain the norm. The importance of experimenting under standard conditions as to the size of the visual field, the method of illumination, etc., is also insisted upon.

Another interesting paper on this subject was that by Dr. W. Peddie, dealing with the effects of fatigue on the sensations produced by colour mixtures. The industrial aspect was brought out in a paper by Mr. Gamble, who put forward suggestions for the standardisation of coloured inks for three-colour printing, and one by Dr. S. G. Barker and Mr. H. R. Hirst on the work of the British Research Association for the Woollen and Worsted Industries with regard to the fading of colours.

The use of the photo-electric cell in photometry is an interesting modern development. Dr. N. R. Campbell, the originator of the idea, and Mr. M. K. Freeth described an investigation, carried out by this method, of the variations in the properties of tungsten filaments in vacuum lamps. The luminous efficiency of successive samples cut from a single filament is found to vary by several parts in a thousand, and the sensitivity of the method is well illustrated by the present study of this phenomenon. The colour temperatures of the samples are compared by means of a rubidium cell, covered by a filter so as to have nearly the same colour-sensitivity characteristic as the eye, and the electrical magnitudes concerned are carefully measured; an estimated accuracy of 0·05 per cent. is achieved, and it is found that more consistent results are obtained if lamps are rated by current instead of by voltage. Mr. T. H. Harrison has extended the method to the measurement of directional candle power, as distinct from the total flux from a lamp. The difficulties are considerable owing to the dissimilarity in the characteristics of individual cells and to fatigue effects, but it is claimed that by means of suitable precautions an accuracy better than 0·1 per cent. can be obtained.

Among the papers on ophthalmic subjects may be mentioned two, by Mr. O. Aves and Mr. W. Swaine respectively, dealing statistically with the distribution among the population of various defects in eyesight. These papers contain much information on such matters as the age and sex distribution of optical defects, the results obtained by correction, the occupations of the patients, etc. There is a tendency for women to seek the optician's aid at an earlier age than men, possibly on account of their being compelled to do needle-work: in each case the frequency-age curve shows two maxima, one in the early twenties and the other in the later forties. As regards the effect of occupation, sewing and kindred tasks claim by far the largest proportion of victims: half as many of the latter are clerks, and one quarter as many are teachers, students, etc. The subject appears to be a somewhat new one, and the authors express dissatisfaction with the material available. A standardised system of analysis also appears to be desirable.

The subject of optical glass is of great interest for those who are concerned as to the fate of the British optical industry. The matter is of wide importance; the optical industry is intimately related to the security and well-being of the nation, for on this branch of the industry all the others are dependent. It is satisfactory to know that whereas before the War only one British firm was engaged in the manufacture, that number has now been trebled. Mr. W. H. Chance and Mr. W. M. Hampton gave an interesting account of the work of their firm, showing that the number of types of glass which it makes has increased from the pre-War figure of 26 to 112 at the present day. Glass colour filters are made in place of the former gelatine filters: a third colour, distinguishable under all conditions from green and red, has been found for railway signals, enabling home signals to be discriminated from distant signals: 'Crookes' glass has been introduced for excluding ultra-violet radiation, and 'vitaglass' for admitting it. The

latter has been fitted in the monkey-house at the Gardens of the Zoological Society at Regent's Park, and is said to have had a beneficial effect on the welfare of the inmates; but it seems doubtful whether the indiscriminate use by the public of lamps emitting strong ultra-violet radiation is in any degree safe.

In connexion with the subject of optical glass, considerable interest attaches to a paper by Mr. W. D. Haigh describing a method for determining the absorption coefficient of glass for light passing through it. His results for British glass are confirmed by the experience of the National Physical Laboratory, and in view of this confirmation of the accuracy of the method, the author's comparison of the transparencies of British and foreign glasses is of some importance. The British glasses are on the whole considerably more transparent to light of the shorter wave-lengths, and are therefore more suitable for the construction of fast camera lenses. A paper by Lord Rayleigh was devoted to the difference in transparency between silica glasses made from sand and from rock crystal respectively, the comparative opacity of the former being attributable to the presence of bubbles.

A number of papers dealt with instrument design and manufacture, but as this aspect of the Convention has already been described in our columns, no further space need be devoted to it here, except as regards two particularly interesting papers on surveying instruments for the Colonies, by Mr. J. L. Rannie and Col. H. St. G. Winterbottom respectively. The first of these authors reviewed the requirements of theodolites for use in Canada, reduction in size and weight and increased speed of manipulation being the chief of these. The paper contains some valuable hints to British manufacturers, and suggests the use of aluminium alloys for the metal parts, elimination of counterpoises by suitable design, sacrifice of excessive accuracy, reduction of the number of micrometers, enlargement of the field of view to facilitate rough alignment, and other innovations. Mr. Rannie believes that definite changes along the lines which he suggests are necessary if Great Britain is to hold the Canadian market. Col. Winterbottom, on the other hand, gave an account of the experience of the Indian Survey which was somewhat more flattering to British manufacture: continental instruments fail to stand the rough conditions of transport to India, and the superior workmanship of British-made instruments is much in their favour. Indeed, it would appear from both these papers that British instruments suffer from the disadvantage (from a manufacturer's point of view) that they do not wear out. It is Col. Winterbottom's opinion that British-made instruments are the most economical in the long run, in spite of their initial cost. C. W. H.

The Sense Organs of Insects.

LITTLE is definitely known from the physiological point of view of many of the sense organs of insects. Except in the case of the eyes and the tactile hairs, it is largely a matter of conjecture to classify them according to function. It is desirable, therefore, to group the various types of these organs into different categories based upon their essential structure.

Most of the sense organs of insects can be classified according to the form of their external cuticular components, as was carried out by Schenk in 1903. Dr. R. E. Snodgrass, in a recent valuable contribution entitled "The Morphology of Insect Sense Organs and the Sensory Nervous System" (*Smithsonian Misc. Coll.* 77, No. 8, 1926), follows in the main this same general classification. His paper commends itself to all interested in the subject, since he has brought together the chief results of the great mass of recent German work in a convenient form. Dr. Snodgrass points out that, since no sensory cytons have been found in the central ganglia of insects, we have to conclude that they are represented by the sensory cells found in relation with the body-wall and alimentary canal. This fundamental conclusion contrasts with what is known concerning the sensory cytons of the vertebrate nervous system, where they are located in the spinal ganglia. Furthermore, the origin and growth of the sensory nerves have not so far been traced in any insects. All we do know is that the sensory nerves of those animals terminate in the central ganglia in finely branching nerve fibrils which constitute the sensory neuropiles.

The simplest type of insect sense organ or sensillum is little more than a slender hair. Histologically it consists of a large hair-forming cell, a membrane cell, which secretes the membrane uniting the hair to its socket, and a sense cell. The latter lies beneath the hypodermis and sends out a nerve process to the base of the hair. It seems reasonable to conclude that such tactile hairs were the first specific sense organs to be acquired by insects, and that from them were developed organs for perceiving chemical stimuli, sound stimuli, or whatever other stimuli are perceptible to insects. In the case of the eyes, the fundamental elements in all varieties of these organs among insects are photoreceptive cells of hypodermal origin. These cells correspond with the sense cells of other sense organs and may be termed the sense cells of the ocular sensillum. Associated with them are cells of hypodermal origin which differ greatly from the enveloping cells of the other sense organs. This fact leads Dr. Snodgrass to conclude that any theory which would derive an ocular sensillum from that of an original sensory hair, as was suggested by Patten in 1890, is too far-fetched to be convincing.

The cuticular part of a sense organ is adapted for the reception of a specific stimulus. In the case of a chemoreceptor the organ is somehow penetrable by odour or taste substances. The idea that such organs were perforated to allow of the substances to be perceived to come in contact with nerve-endings is not upheld. The cuticular walls of these sense organs are, in many cases, not more than half a micron in thickness, and it is reasonable to suppose that they allow of the passage of odour or taste substances. In support of this view Dr. Snodgrass quotes the observation of Vogel, who noted that the membranous cupola of a basiconic sensillum of the wasp is coloured by haematoxylin, and hence is permeable by it. There is no doubt that a better acquaintance with the physiology, the senses, and the tropisms of insects will provide an insight into how these creatures so successfully maintain their dominant place in Nature, notwithstanding man's most energetic efforts to repress them. A. D. I.

Geophysical Observations in France.

THE third volume of the "Annales" of the Institut de Physique du Globe de l'Université de Paris and of the Bureau Central de Magnétisme Terrestre, the two institutions directed by Prof. Maurain, has been issued recently (Paris: Les Presses Universitaires de France, 1925). The volume is devoted mainly to observations made during the year 1923. The principal geophysical observatory in France is at Val-Joyeux, 24 kilometres west of Paris. For this observatory hourly values of the magnetic elements are published. Systematic magnetic observations have been re-established recently at Nantes on the lower Loire, and the results of the first complete year's work are now given. It appears that, in spite of the disturbance due to electric trams, which come within 450 metres of the Observatory at Nantes, there is satisfactory agreement between the two stations, which are in nearly the same latitude. For the year 1923 the range[1] of the mean diurnal variation of declination was 6·46′ at Val-Joyeux and 6·33′ at Nantes; the corresponding figures for horizontal force were 16γ and 16γ.

Another new departure is the organisation of regular observations of atmospheric electricity at Val-Joyeux. Potential gradient in the open is recorded directly by the method adopted by Norinder in Sweden. A radium collector is suspended about 2 metres above ground in the middle of a wire 16 metres long, and the potential is shown by a Benndorf electrograph. The difficulty in such operations, a difficulty which has made many old records of atmospheric potential useless, is to ensure good insulation. In the present instance there is no provision for warming the hut, so that the deposit of moisture on cold nights would seem to be inevitable. It is therefore to be regretted that there is nothing in M. Salles's account of the work at Val-Joyeux to show what control observations are made. The conclusions as to the average potential gradient must be accepted with some reserve; as the figures stand, they suggest that the atmosphere at Val-Joyeux is much purer than that at Kew. For Val-Joyeux the average gradients in June and December 1923 are given as 65 volts and 123 volts per metre respectively. According to Chree, the averages for Kew (covering 1898–1912) are 207 volts in June and 409 volts in December.

A résumé of the observations made with the Ångström pyrheliometer at Parc St. Maur from 1907 to 1923 is given by M. Brazier. The brightest sunshine observed was on March 26, 1915, 1·44 calories per square centimetre per minute.[2] The 'solar constant' being 1·94, nearly 75 per cent. of the solar energy was getting through the atmosphere on that occasion. The highest transmission coefficient (estimated for a vertical sun) was recorded in December, 87 per cent., whereas in the summer months no co-efficient was estimated as more than 76 per cent. This contrast is attributed to the stopping power of the excess of water vapour in the summer air.

Several sections of the volume are devoted to accounts of parts of the magnetic survey of France. The previous survey was in 1896. The interval is large enough for a diminution of declination by 3°. There is some indication of local peculiarities, but the discussion of these is reserved until the completion of the survey.

Mention must also be made of a series of articles co-ordinating all available information as to magnetic surveys of French dependencies. In the present volume maps of Indo-China and Madagascar are reproduced. The latter map is remarkable for the complexity of the lines in the centre of the island. The geological significance of the contortions has been worked out by the director of the Tananarive Observatory. These articles by Mlle. Homery will be very useful for reference.

[1] In each case the figure quoted is the difference between the highest and lowest of the mean hourly values for the year.

[2] The reading has been adjusted to the Smithsonian scale; the date is misquoted in the table on p. 137.

Ethnic Relations in India and the Near East.

IN a paper read before the Royal Anthropological Institute (Indian Section) on April 30 on this subject, Mr. L. H. Dudley Buxton stated that the three great regions of the eastern Mediterranean, Mesopotamia, and India have been the mothers of civilisations on which to a greater or lesser degree our own civilisations are based. In them also have arisen the three great religions of the world, Christianity, Mohammedanism, and Buddhism. Superficially their inhabitants seem to be very unlike, but a closer examination reveals many traits in common, both with each other and with the people of western Europe.

Excluding the Mongoloid peoples, who are really intruders into this region, though their arrival was probably far back in the past, we have two great groups, roundheads and longheads. Both types are found even in the earliest graves excavated up to the present. Any race which is composed of both longheads and roundheads shows considerable variety, as might be expected, both types appearing in the mixed race in each generation.

Such a mixture was found in the earliest graves so far excavated at Kish in Mesopotamia, and still continues. In India the rounder the heads of each group of people examined the more variable they are, but in the Near and Middle East the least variable are the extreme longheads and the extreme roundheads. This suggests that in India we have basic stocks who are longheads and roundheaded intruders; whereas westwards we have both types represented in a pure as well as a mixed state.

Further analysis shows that in the Near East there is a type akin to Stone Age man, such as 'Combe Capelle.' This type is probably also represented in India. There are even suggestions that a more primitive type lingered on in prehistoric times well after the Stone Age. The second type of longheads is akin to the well-known Mediterranean man. This or a kindred type is also found in India. But here we have also a more primitive type, probably specialised for life in the tropics, and akin to the very primitive Australian aboriginal. Whether this type ever occurred in the Near East is uncertain. The roundheads which are intruders in India are dominant in much of the Near East, but never succeeded in becoming more than an element in the population of the Middle East, although they can be found in units almost everywhere there.

All this elaborate racial mixing probably took place at a remote period, long before the dawn of history, and it seems difficult to identify any physical type with any known historical people. Civilisations have come and gone, especially in the land of the two rivers, but always the physical type of the people seems much the same. It is to be hoped, therefore, that some lucky chance will give us graves at the very beginning of the Bronze Age or before, so that the actual date of the invasions of the roundheads and of the later comers among the longheads may be traced.

University and Educational Intelligence.

BIRMINGHAM.—Sir Oliver Lodge will deliver the Huxley Lecture on Tuesday, May 4, at 5.30 P.M., his subject being "Difficulties about the Ether."

CAMBRIDGE.—Certain regulations which are to take effect as ordinances on the commencement of the new statutes have been promulgated. Among these are the regulations for the committee which is to superintend the Natural Sciences Tripos. There are always present among the senior members of the University a certain number who are dissatisfied with the Tripos; these will now be able to bring their theories to the notice of an official body constituted for the purpose. It is not improbable that this committee, which now seems a simple innovation, will occasionally prove to be a storm-centre of wordy warfare.

Sir John Russell and some of the staff of the Rothamsted Experimental Station are again giving a course of public lectures on the chemistry, physics, and biology of the soil. Last year the course attracted considerable attention and was an undoubted success. The lectures are being given on Tuesdays, Wednesdays, and Thursdays, at 2.15 P.M.

The Board of Research Studies has presented its annual report; the total number of registered research students shows a slight increase, for which mathematics and geology are mainly responsible. It is satisfactory to note that graduates of the University are now registering as students for the doctorate of philosophy more frequently than formerly. At present, of a total of 276 research students, 90 are from Cambridge, 89 from other universities of the British Isles, 44 from the colonies, and 37 from the United States.

An appointment will be made towards the beginning of July next to a Busk Studentship in Aeronautics. The studentship is of the value of about 150*l.*, tenable for one year from October 1, and is open to any man or woman being a British subject and of British descent who has not attained the age of twenty-five years on that date. The holder of the studentship will be expected to engage in research in aeronautics, and specially in subjects such as stability problems, meteorological questions bearing on flight, or the investigation of gusts, treated either experimentally or mathematically, in which the late Edward Busk was specially interested. Forms of application can be obtained from Prof. B. Melvill Jones, Engineering Laboratory, Cambridge, and must be returned not later than May 12.

GLASGOW.—Dr. R. H. Thouless, fellow of Corpus Christi College, Cambridge, Arnold Gerstenberg and Burney student and prizeman, senior lecturer in psychology at the Victoria University of Manchester, has been appointed lecturer and head of the department and laboratory of psychology in the University, in succession to the late Dr. Watt.

A memorial lectureship and medal have been founded in the University in commemoration of the late Prof. Sir William Macewen, F.R.S. The lectureship will be biennial, and the memorial lecture will deal with advances in surgery. The first memorial lecture will be given in 1927 by a distinguished surgeon unconnected with Glasgow. The memorial medal will be awarded annually to the most distinguished candidate in the final or qualifying examinations in surgery of the year.

LONDON.—The following courses of free public lectures are announced: At the Imperial College of Science and Technology—Royal School of Mines—at 5.15 on May 3, 10, and 17, "Past Ice Ages of the World, and their Control of Animal and Plant Life, with special reference to the Australian Evidence," by Sir T. W. Edgeworth David; at King's College, at 4.30 on May 25, June 1, 8, and 15, "The Constituents and Coagulation of Blood Plasma," by Dr. J. W. Pickering; and at University College at 5.30 on May 27, 28, and 31, "The New Aspect on Strong Electrolytes," by Prof. Niels Bjerrum (of the University of Copenhagen). No tickets will be required for either course.

THERE will be an election to junior Beit Memorial Fellowships for medical research in July, and applications for the fellowships are invited. The annual value of each is 350*l.* and the tenure usually three years. The latest date for the return of application forms (which should be sent to Sir James K. Fowler, 35 Clarges Street, W.1) is June 1.

THE Council of the London (Royal Free Hospital) School of Medicine for Women invites applications for the Dr. Edith Pechey Phipson post-graduate scholarship of 100*l.* a year for not more than three years. The scholarship is open to all medical women, preferably coming from India, or going to work in India, for assistance in post-graduate study. Applications must be sent to reach the Warden and Secretary of the school, 8 Hunter Street, W.C.1, by May 31.

THE Oxford and Cambridge Appointments Boards have published reports for the year 1925 showing that the appointments obtained during the year by their candidates numbered 210 and 399 respectively. The former are classified as Government 42, educational 59, business and industrial 32, journalistic, secretarial, etc., 10, and temporary 67; the latter as Government departments (mainly scientific) 16, administrative posts in commerce and industry 81, manufacturing and technical 89, Colonial administration 37, agriculture and forestry 11, Indian and Colonial railways 16, railway traffic 4, journalism and publicity 2, publishing 2, articled clerkships 6, museums 2, architecture 1, medical 2, secretaryships 6, educational 119, miscellaneous 5. The Cambridge report says that engineering students were readily placed. Many opportunities exist for engineers with a knowledge of chemistry, or chemists with a knowledge of engineering, but candidates properly equipped on both these sides are very few. More physical chemists could have been placed. The number of candidates who registered for the first time during 1925 was 582 at Cambridge and 473 at Oxford.

HULME HALL, Manchester, announces that an examination will be held in the second week of May for Entrance Scholarships. An interesting feature of the entrance conditions prescribed alike for scholarship candidates and other candidates for admission except advanced students is a test of their "alertness, intelligence, and intellectual outlook, their personal qualities of mind and mental equipment, and their mastery of the modern standard English dialect." The test is conducted by means of a paper of general questions—historical, scientific, economic, social, political, geographical, literary, artistic, and ethical—and a *viva voce* examination, including the reading aloud of passages of English prose. The total amount of an undergraduate's annual expenditure while a member of the Hall, exclusive only of university fees (15*l.* to 40*l.* according to faculty), clothing, vacation and travelling expenses, is shown by recent inquiries among the students to average 107*l.* The Hall aims at reproducing the best features of college life at Oxford or Cambridge, an excellent summary of which is given in a leaflet circulated with its prospectus entitled "University Life: Residence in Hall or Not?"

Contemporary Birthdays.

May 1, 1852. Prof. Ramón y Cajal, For.Mem. R.S.
May 1, 1866. Sir A. Trevor Dawson, Bart., M.Inst.C.E.
May 1, 1858. David Hooper, LL.D.
May 2, 1868. Prof. Robert W. Wood, For.Mem.R.S.
May 5, 1882. Sir Douglas Mawson, F.R.S.
May 5, 1860. Dr. Charles Chree, F.R.S.
May 6, 1866. Sir Murdoch Macdonald, M.Inst.C.E.
May 6, 1848. Dr. H. R. Procter, F.R.S.
May 7, 1863. Sir John Rose Bradford, F.R.S.

Prof. RAMÓN Y CAJAL, the eminent physiologist, was born at Petilla, Spain. He was Nobel laureate (with Golgi) in 1906.

Sir TREVOR DAWSON received his technical training at the Royal Naval institutions at Gosport and Greenwich. He is the inventor and constructor of many improvements relating to artillery. Sometime experimental officer to the Home Office Committee for the investigation of gas cylinders, he is a past president of the Junior Institution of Engineers.

Dr. HOOPER, an authority in pharmacology and economic botany, was born at Redhill. Quinologist to the Government of Madras from 1884 to 1897, he was afterwards, before returning to England, curator of the Industrial Section of the Indian Museum, Calcutta.

Prof. WOOD was born at Concord, Mass. Educated at Harvard, Johns Hopkins, and Berlin, from a post at the University of Wisconsin, he became (1901) professor of experimental physics in Johns Hopkins University, Baltimore. He is specially identified with researches in optical science, in which he has shown experimental skill of a high order.

Sir DOUGLAS MAWSON is a graduate of the University of Sydney. He was born at Bradford, Yorkshire. His pioneering work in Antarctic exploration is well known. He was with Sir Ernest Shackleton in his southern expedition of 1907, and he was leader of the Australian Antarctic Expedition, 1911–14. The Royal Geographical Society awarded him its Antarctic medal in 1909, and its distinction of the Founder's medal in 1915. The president of the Geological Society (Mr. Lamplugh) in handing Sir Douglas the Bigsby medal in 1919, referred to his arduous geological researches in the New Hebrides, in the Broken-Hill district, and in other regions in Australia, as well as the systematic study of Australasian minerals, in themselves a full measure of achievement.

Dr. CHREE, who, after attending the Grammar School, Old Aberdeen, proceeded thence to the University of Aberdeen and afterwards to Cambridge, becoming, at the latter university, sixth wrangler. Until 1925 he was, for more than thirty years, superintendent of Kew Observatory, Richmond. The relationship between solar manifestations and terrestrial magnetism has specially engaged his attention. In 1919 Dr. Chree was Hughes medallist of the Royal Society.

Sir MURDOCH MACDONALD, following extensive constructional railway work in Scotland, engaged for many years in engineering schemes under the Public Works Ministry of Egypt.

Sir JOHN ROSE BRADFORD, who is a Londoner, was educated at University College School. A former secretary of the Royal Society, he was recently elected president of the Royal College of Physicians.

Societies and Academies.

LONDON.

Society of Public Analysts, April 7.—H. Droop **Richmond** and J. A. **Eggleston**: The analysis of Acetic anhydride. By adding 2 c.c. of acetic anhydride to 200 c.c. of a mixture of 94 parts of toluene and 6 parts of aniline, and measuring the rise of temperature produced in the reaction, a determination of the strength of the acetic anhydride can be made with an accuracy comparable to that of the method of Henschutkin and Wasilieff. In very accurate work a correction is necessary for the heat evolved in the formation of aniline acetate.—H. Droop **Richmond** and Eric H. **England**: The analysis of glacial acetic acid. Acetic acid is almost unique in that specific gravity falls with increasing percentage, whilst the freezing point rises. Impurities, of which propionic acid is the most important, lower both specific gravity and freezing point. By calculating the specific gravity equivalent to the freezing point and subtracting from it the specific gravity found, a close approximation to the percentage of propionic acid can be obtained by dividing by 0·00135. Other impurities are aldehydes and ketones, probably chiefly propionaldehyde and homolgues.—J. F. **Tocher**: (1) Errors of judgment in chemical analysis. In experiments on the titration of sodium hydroxide solution with *N*-sulphuric acid, the mean results of successive determinations during a forenoon were of a periodic character. On an average the first two determinations were less trustworthy than the others. The variations in the personal equations of observers were independent of the apparatus and the material.—(2) Variations in the composition of milk. The percentage of butter fat tends to decrease slightly with increasing yield per milking for a particular animal, but the total amount of butter fat (and also of solids not fat) increases proportionally with increased yield.—E. R. **Bolton** and K. A. **Williams**: A test for Tung oil. Previous attempts to obtain a definite and constant petroleum spirit extract of unpolymerised matter from the residue of Worstall's test have failed owing to incomplete and uncontrolled polymerisation. A definite yield of extract varying between narrow limits can be obtained under proper conditions, and adulterants are readily disclosed by the yield of extract in excess of the standard amount. Most of the oils likely to be used as adulterants are completely recovered in the extract; linseed oil being an exception, in which case approximately 50 per cent. is retained in the polymerised mass.

Royal Meteorological Society, April 21.—J. **Glasspoole**: The driest and wettest years at individual stations in the British Isles, 1868–1924. The data have been obtained for some 250 long-period stations distributed over the British Isles as regards the driest and wettest years. Thus for Camden Square (London): average annual rainfall, 24·47 in.; driest year 1921, with 14·60 in. or 60 per cent. of the average; wettest year 1903, with 38·10 in. or 156 per cent. of the average. The years 1887 and 1921 were the driest years in the series 1868–1924 over 40 and 31 per cent. of the British Isles, and the years 1872 and 1903 were the wettest years over 49 and 19 per cent. of the whole British Isles respectively. Almost every year was the driest or the wettest for one place or another in these islands.—C. E. P. **Brooks**: (1) The meteorological conditions during the glaciation of the present tropics, being some remarks on the climatological basis of Wegener's theory of continental drift. The reconstruction of Permo-

Carboniferous geography given by Wegener shows a large continent formed by the union of South America, Africa, India, Australia, and Antarctica, surrounding the south pole and bearing extensive ice-sheets, while the equator passed through Europe and the United States. Recent researches have shown, however, that in the latter country also there were a number of powerful glaciers extending to sea-level. Thus there are the same climatic objections to Wegener's reconstruction as to that based on the present positions of the continents. The reconstruction of the Upper Carboniferous given by Th. Arldt ("Handbuch der Palæogeographie") is accordingly taken as a basis, and the probable distribution of warm and of cold ocean currents and of winds is discussed. A warm current would traverse the region of the coal-measures, and the American glaciation is also readily explicable owing to the neighbourhood of an arm of the Arctic Ocean, while even the glaciation of the tropics may not be a vital objection.—(2) The variation of pressure from month to month in the region of the British Isles. A chart of the deviation of means of pressure from normal in any month usually shows 'centres' of maximum excess or maximum deficit. Centres of excess of pressure tend to move along fairly well-defined tracks and generally from west to east. The main track runs from Alaska south-eastward to the centre of the United States, then eastward to the Azores, north-eastward to the British Isles or Scandinavia, and again eastward to northern Russia or the Kara Sea. This would take about six months, though no single centre was found which persisted long enough to make the whole journey. Centres of deficit are more variable in their movements, but also tend to move from west to east.

DUBLIN.

Royal Dublin Society, March 23.—W. E. **Adeney**: On the rate and mechanism of the aeration of water under open-air conditions. The bubble method employed by Adeney and Becker for the investigation of the process and rates of solution of atmospheric nitrogen and oxygen by fresh and salt waters, affords a means of determining the rates of solution of these gases, when every part of the water is successively exposed to them in thin films, and becomes gradually and completely aerated independently of evaporation or of downward 'streaming'. The aeration of quiescent bodies of fresh water by downward 'streaming' may take place 113, 56, 245, and 185 times slower than the initial rate of solution of the surface film 0·05 cm. thick, according to the humidity of the air passing over their undisturbed surfaces. When, however, the surface of the water is kept in a continuous state of turbulent agitation, as in a bio-aeration tank for the purification of sewage liquors, the effective area of water exposed to the air becomes so much increased that the downward 'streaming' is greatly augmented, and the rate of aeration of the water may become equal to, or even exceed, that calculated from the rates of solution found by the bubble experiments for films 0·05 cm. thick, for the given depth of the water, assuming the exposed surface to remain in an undisturbed condition.—J. **Bell**: The constitution of dicyanodiamide. In Bamberger's experiments on the action of nascent hydrogen on dicyanodiamide, hydrolysis to dicyanodiamidine takes place to the extent of 50 per cent. A mercury derivative of dicyanodiamide is also described.—J. **Doyle** and Miss P. **Clinch**: The pentosan theory of cold-resistance applied to conifers. The pentosans of conifers can be classed in three groups: (*a*) water-soluble pentosans, (*b*) pentosans subsequently extractable with 1 per cent. hydrochloric acid, and (*c*) pentosans still remaining and only extractable with 12 per cent. hydrochloric acid. All three classes vary considerably throughout the year, though not independently, the variation in classes (*a*) and (*b*) being reciprocal. Cupressus is remarkable in having a very high winter content of water-soluble pentosan, this class being usually present in minimum quantity during the winter months. The H-ion concentration of conifer leaves shows little seasonal variation. The leaves are distinctly acid—from *p*H 3 to 4. Cupressus is distinctly less acid than the other forms examined. No relations, seasonal or otherwise, can be established between hardiness in conifers and pentosan content.

PARIS.

Academy of Sciences, March 29.—Paul **Appell**: Some formulæ relating to Euler's constant, C.—F. E. **Fournier**: General expressions of the resistance, R, of water to the translation of hulls, at all possible velocities.—M. **Brillouin**: Is the moon radioactive? The hypothesis that the moon is radioactive is regarded as probable, and this radioactivity may exert a sensible action upon the earth's outer atmosphere.—— d'**Arsonval** and F. **Bordas**: The determination of the impurities in the atmosphere. Some results obtained with a modified Owens gauge in the centre of Paris.—Paul **Sabatier** and J. F. **Durand**: An attempt at the catalytic hydrogenation of ethylene oxide. Ethylene oxide mixed with hydrogen and passed over reduced nickel heated to 125° to 150° C. is not reduced, but is converted into acetaldehyde and condensation products of the latter.—R. **Maire**: The vegetation of south-west Morocco.—Émile Forgue was elected a corresponding member for the Section of Medicine and Surgery in succession to the late M. Depage.—Walter **Saxer**: The exceptional values of the successive derivatives of meromorph functions.—I. **Karamata**: Certain limits connected with Stieltjes integrals.—Paul **Lévy**: Remarks on the methods of summation of divergent series.—— **Hadamard**: Remarks on the two preceding communications.—Leonida **Tonelli**: The integration of suites of functions capable of summation.—Louis **Roy**: The dynamic adiabatic law relating to elastic lines.—— **Amans**: The aerodynamics of windmills.—Jean Jacques **Trillat**: Researches on the phenomena of lubrification by means of X-ray spectrography. The X-ray spectra prove that as the result of friction between two surfaces the fatty layer is stratified.—Michel O. **Samsoen**: The crystallisation of glycerol. In the course of some experiments on the change in the coefficient of expansion of glycerol in the neighbourhood of −62° C., it was noticed that on warming up, the glycerol always crystallised spontaneously, centres of crystallisation commencing to appear about −23° C. Unless the prolonged preliminary cooling has been carried below −40° C., crystallisation does not take place.—John H. **Shaxby**: Formulæ relating to the density of a fluid and the molecular diameter.—Henri **George**: The manufacture of transparent quartz glass. The difficulty of freeing fused silica from gas bubbles is well known. The author has found that a transparent fused silica glass, free from bubbles, can be obtained by simple fusion in a crucible of certain natural quartzites. These quartzites are of high purity (99·9 per cent. silica) and there are no gaseous inclusions.—J. **Hugounenq** and J. **Loiseleur**: The use of glycogen in the preparation of colloidal metals. Colloidal solution of many metals may be prepared by means of glycogen, which behaves both as stabiliser and reducer. Details are given of the preparation of colloidal silver, mercury and bismuth.—Charles **Prévost**: The catalytic dehydration of the vinylalkyl-

carbinols. Ethylvinylcarbinol, dehydrated by the catalytic action of alumina at 350°-365° C., gives a 60 per cent. to 70 per cent. yield of 1:3 pentadiene.—Ch. **Courtot** and J. **Bonnet**: Contribution to the study of the π of sulphonation.—E. **Delcambre**, P. **Idrac** and F. **Geoffre**: A new temperature and pressure recorder for the study of the higher atmosphere.—P. L. **Mercanton**: The magnetisation of the Greenland basalts.—G. **Mangenot**: The existence of a remarkable functional arrangement in the orifices of the liber sieves.—V. G. **Korneff**: Measurement of the force of suction of the soil for water.—C. **Rouppert** and H. **Jedrzejowski**: The action of the radiation of radioactive bodies on plant pearls.—H. **Hérissey**: The detection of asperuloside in plants. The extraction of this glucoside from *Galium Aparine*.—Theodor **Lipmaa**: The physical and chemical properties of rhodoxanthine.—R. **Fosse**: A new natural principle in plants: allantoic acid.—E. **Roubaud** and J. **Colas-Belcour**: The obligatory winter sleep and its various manifestations in mosquitoes indigenous to France.—**Gruvel**: The development of trout culture in Morocco.—J. **Sabrazès**: The simple and rapid coloration of the treponeme of syphilis. The comparative affinity for stains of the Spirochætes.

ROME.

Royal Academy of the Lincei, February 21.—V. **Volterra**: Variations and fluctuations in the number of individuals in animal species living together.—O. M. **Corbino**: Magneto-optic phenomena in fields which are varying rapidly. Theory predicts that the Zeeman phenomenon should respond instantaneously to the changes of a field varying with the time according to any law and with any rapidity. In carbon disulphide the magnetic rotatory dispersion follows quantitatively the oscillations of a high-frequency field as far as the shortest persistent waves (300 metres) with which it was found possible to experiment.—Ferruccio **Zambonini** and S. **Restaino**: Double sulphates of rare earth and alkaline earth metals (v.). Cerous ammonium sulphate. The crystallographic and other characters of the two compounds, $Ce_2(SO_4)_3$, $(NH_4)_2SO_4$, $8H_2O$, and $Ce_2(SO_4)_3$, $5(NH_4)_2SO_4$, are described.—Umberto **Cisotti**: Resolution of harmonic problems in a plane area of indefinite extent with n circular gaps of small diameter.—Azeglio **Bemporad**: A new method of studying experimental results. The method recently described by Cantone has been applied to the results of astronomical measurements, and is closely analogous to the hodograph so frequently used in mechanics and other branches of mathematics.—G. **Vranceanu**: The integration of the problem of two bodies in the case in which the mass is a linear function of the time.—Emilio **Adinolfi**: The absorption spectrum of potassium and calcium permanganates.—Washington Del **Regno**: The behaviour of selenium subjected to the action of mesothorium radiations. Exposure of selenium to mesothorium radiation produces a marked variation in the electrical resistance of this element, the effect being due mostly to the β-rays.—G. **Carobbi**: The chemical composition of the orthite of Ambatofotsikely (Madagascar).—Pia **Gravino**: The antimonite of Wolfsberg (Harz).—G. R. **Levi** and R. **Haardt**: The catalytic action of metals of the platinum group and their degree of subdivision (ii.). The results already published, together with those now obtained with palladium, rhodium, iridium, ruthenium, and osmium show that, in the form of 'black,' these metals are so highly subdivided that the granules are comparable with those of colloidal metals. Measurements of the X-ray diagrams show that, within moderately wide limits, the dimensions of the granules depend on the method of preparation as well as on the nature of the metal. The fact that the granules of the spongy metals are large in comparison with those of the 'blacks' explains the practical advantage of subdividing the catalyst on a diluent material, such as asbestos or porcelain.—A. **Ferrari**: Röntgenographic investigation of the crystalline lattices of manganous fluoride and manganese dioxide. Manganous fluoride crystallises in the tetragonal system, the axial ratio being $c:a=0{\cdot}675$. Its structure is of the rutile type, the dimensions of the elementary cell which contains two molecules being $a=4{\cdot}865$ and $c=3{\cdot}284$ Å.U.; the calculated and observed values of the density are respectively 3·97 and 3·98. The dioxide exhibits the same lattice as the fluoride, the dimensions being $a=4{\cdot}380$ and $c=2{\cdot}856$ Å.U., the calculated specific gravity is 5·27, whereas the experimental value is 5·08, and the axial ratio, $c:a=0{\cdot}625$, is decidedly lower than that found crystallographically, namely, 0·664. The dioxide exists in only one crystalline form.—Enrico **Carozzi**: A chromiferous spessartite from St. Barthélemy (Valle d'Aosta).—Arnaldo **Masotti**: Uniform rotation of a solid cylinder in an indefinite perfect liquid. Extension of Kutta and Joukowski's theorem.

Official Publications Received.

Classified List of Smithsonian Publications available for Distribution, March 15, 1926. Compiled by Helen Munroe. (Publication 2866.) Pp. v+30. (Washington, D.C.: Smithsonian Institution.) [Corrected entry.]

Engineering Abstracts from the Current Periodical Literature of Engineering and Applied Science, published outside the United Kingdom. Published by the Institution of Civil Engineers with the Cooperation of other Engineering Societies in Great Britain and the Dominions. New Series, Nos. 26 and 27, January and April 1926. Pp. 350. (London: Institution of Civil Engineers.)

Agricultural Research Institute, Pusa. Bulletin No. 164: Standard Methods of Analysis of Fertilizers. By Dr. J. Sen. Pp. iii+14. (Calcutta: Government of India Central Publication Branch.) 4 annas; 6*d*.

Memoirs of the Indian Meteorological Department. Vol. 24, Part 11: Rainfall Types in India in the Cold Weather Period, December 1 to March 15. By Sir Gilbert T. Walker and Dr. J. C. Kamesvara Rav. Pp. 317-354. (Calcutta: Government of India Central Publication Branch.) 4 annas; 5*d*.

Department of Commerce: U.S. Coast and Geodetic Survey. Serial No. 312: Terrestrial Magnetism; Results of Magnetic Observations made by the United States Coast and Geodetic Survey in 1924. By Daniel L. Hazard. (Special Publication No. 116.) Pp. 50. (Washington, D.C.: Government Printing Office.) 10 cents.

Journal of the Indian Institute of Science. Vol. 8A, Part 16: The Occurrence of Sylvestrene. By B. Sanjiva Rao and John Lionel Simonsen. Pp. 287-294. 8 annas. Vol. 9A, Part 1: Contributions to the Scientific Study of the Lac Industry. Part xi: Early Recognition of Sex among Lac Insects. By S. Mahdihassan. Pp. 24+10 plates. 4 rupees. (Bangalore.)

Department of Commerce: Bureau of Standards. Circular of the Bureau of Standards, No. 279: Relations between the Temperatures, Pressures and Densities of Gases. Pp. 85. 25 cents. Circular of the Bureau of Standards, No. 300: Architectural Acoustics. Pp. 9. 5 cents. (Washington, D.C.: Government Printing Office.)

Bulletin of the American Museum of Natural History. Vol. 56, Art. 1: The Hemicyoninæ and an American Tertiary Bear. By Childs Frick. Pp. 119. (New York.)

Papers and Proceedings of the Royal Society of Tasmania for the Year 1925. Pp. v+253+xiv+19·36+24 plates. (Hobart). 10*s*.

Department of Commercial Intelligence and Statistics, India. Agricultural Statistics of India, 1923-24. Vol. 1: Area, Classification of Area, Area under Irrigation, Area under Crops, Live-Stock, Land Revenue Assessment and Harvest Prices in British India. Pp. xi+81+7 plates. (Calcutta: Government of India Central Publication Branch.) 1 rupee; 1*s*. 9*d*.

Year-Book of the Department of Agriculture, Ceylon, 1926. Pp. iv+62+22 plates. (Peradeniya.)

Transactions of the Royal Society of Edinburgh. Vol. 54, Part 2, No. 10: Geology of the Outer Hebrides. Part iii: North Uist and Benbecula. By Prof. T. J. Jehu and R. M. Craig. Pp. 467-489+4 plates. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.) 4*s*. 6*d*.

Diary of Societies.

SATURDAY, MAY 1.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (South-Eastern District) (at Grand Hotel, Margate), at 1.—E. A. Borg and others: Discussion on Notes on Municipal Work at Margate.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. P. C. Buck: The Song Form in England as represented by Stanford.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.—Annual Meeting.

MONDAY, MAY 3.

CAMBRIDGE PHILOSOPHICAL SOCIETY (in Cavendish Laboratory), at 4.30.—Prof. Sir J. Larmor: Insular Gravity and Oceanic Isostasy.—W. A. D. Rudge: A Mechanical Model of the Rutherford-Bohr Atom.—Miss C. A. Scott: On the Higher Singularities of Plane Algebraic Curves.—*Communicated by title only*:—Ž. Marković: Sur la non-existence simultanée de deux fonctions de Mathieu.—C. G. F. James: On the Multiple Tangents and Multisecants of Scrolls in Higher Space.—E. V. Appleton: On the Diurnal Variation of Ultra-short Wave Wireless Transmission.—R. Vaidyanathaswamy: The (2, 1) Correspondence.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.—General Meeting.

SOCIETY OF ENGINEERS (in Demonstration Room of the Science Museum, South Kensington), at 5.30.—H. W. Dickinson: Landmarks in the History of Prime Movers.

INSTITUTION OF ELECTRICAL ENGINEERS (Western Centre) (at Chamber of Commerce, Swansea), at 6.—Prof. S. P. Smith: An All-Electric House.

ARISTOTELIAN SOCIETY (at University of London Club), at 8.—Prof. A. E. Heath: Objectivity in Science.

ROYAL SOCIETY OF ARTS, at 8.—C. R. Peers: Ornament in Britain (Cantor Lectures) (3).

SOCIETY OF CHEMICAL INDUSTRY (London Section) (Annual and Ordinary Meetings), at 8.—S. Dickson and R. H. H. Stanger: Discussion on Modern Portland Cement Manufacture.

ROYAL SOCIETY OF MEDICINE (Social Evening), at 9.30.—Sir Humphry Rolleston: Some Worthies of the Cambridge Medical School (Address).

TUESDAY, MAY 4.

ROYAL SOCIETY OF ARTS (Dominions and Colonies Section), at 4.30.—C. Ponsonby: Nyasaland.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. J. Barcroft: Organs of Multiple Function (4): Lungs.

ROYAL SOCIETY OF MEDICINE (Orthopædics Section), at 5.30.—Annual General Meeting.

INSTITUTE OF MARINE ENGINEERS, at 6.30.—J. A. Aiton: Steam Pipes for Super-High Pressure.

RÖNTGEN SOCIETY (at British Institute of Radiology), at 8.15.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.30.—Rev. P. Schebesta: The Semang (Negrito Aborigines) of the Malay Peninsula.

WEDNESDAY, MAY 5.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—R. M. Jehu: The Geology of the District around Towyn and Abergynolwen (Merioneth).—K. A. Davies: The Geology of the Country between Drygarn and Abergwesyn (Breconshire).

INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section), at 6.—Dr. R. L. Smith-Rose and R. H. Barfield: On the Cause and Elimination of Night Errors in Radio Direction Finding.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at Chemical Society), at 8.—A. Chaston Chapman: The Detection and Determination of Glycerin in Tobacco.—H. Toms: Further Notes on the Crystalline Bromides of Linseed and other Oils.—A. Bakke and P. Henegger: The Polarimetric Determination of Sucrose in Condensed Milk.—H. L. Smith and J. H. Cooke: The Determination of very small Quantities of Iron.—Dr. W. R. Schoeller: The Separation of Iridium from Iron.—Jitendra Nath Rakshit: The Determination of Total Alkaloids, Sugar and Oily Substances in Opium.

ROYAL SOCIETY OF ARTS, at 8.—C. F. Elwell: Radio: Its Past, Present, and Future.

ROYAL SOCIETY OF MEDICINE (Surgery Section), at 8.30.—Annual General Meeting.—Dr. W. E. Gye: The Origin of Tumours.

ROYAL MICROSCOPICAL SOCIETY (Biological Section).

THURSDAY, MAY 6.

IRON AND STEEL INSTITUTE (Annual Meeting) (at Institution of Civil Engineers), at 10 A.M.—Presentation of Bessemer Gold Medal to Sir Hugh Bell, Bart.—Sir W. Peter Rylands: Presidential Address.—Report on Heterogeneity of Steel Ingots. By a Sub-Committee of Committee No. 5, consisting of Dr. W. H. Hatfield, T. P. Colclough, W. J. Dawson, J. H. S. Dickenson, A. P. Hague, E. F. Law, S. A. Main, T. M. Service, and J. H. Whiteley.—J. H. S. Dickenson: A Note on the Distribution of Silicates in Steel Ingots.—J. H. Whiteley: Ghost Lines and Banded Structure of Rolled and Forged Mild Steels.—At 2.30.—W. H. Dearden and C. Benedicks: Magnetic Changes in Iron and Steel below 400° C.

ROYAL SOCIETY, at 4.30.—Prof. A. S. Eddington: Diffuse Matter in Interstellar Space (Bakerian Lecture).

ROYAL SOCIETY OF ARTS, at 4.30.—Sir Frank Baines: Preservation of Ancient Cottages.

LINNEAN SOCIETY OF LONDON, at 5.—Capt. J. G. Dollman: Exhibition of a supposed new 'Mutation' in the Rabbit.—Dr. A. W. Hill: The Genus Lilæopsis.—R. D'O. Good: The Genus Empetrum.—J. T. Cunningham: On the Nuptial Pads of Frogs and Toads.

INSTITUTE OF PATHOLOGY AND RESEARCH (ST. MARY'S HOSPITAL, W.2), at 5.—Prof. J. Barcroft: Recent Work on the Spleen (Lecture).

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Sir William Bragg: The Imperfect Crystallisation of Common Things (2).

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—Annual General Meeting.

INSTITUTION OF AUTOMOBILE ENGINEERS (Derby Graduates' Meeting) (at Cavendish Café, Derby), at 7.30.—J. Topham: Inspection in the Building of an Automobile Chassis.

INSTITUTION OF STRUCTURAL ENGINEERS, at 7.45.—Annual General Meeting.—At 8.—Major J. Petrie: Some Lessons from Practical Experience, with Special Reference to Structural Work on Railways.

CHEMICAL SOCIETY, at 8.—Dr. C. K. Ingold, E. Holmes, and E. H. Ingold: The Nature of the Alternating Effect in Carbon Chains. Parts IV., V., VI., and VII.—Dr. C. K. Ingold, C. W. Shoppee, and J. F. Thorpe: The Mechanism of Tautomeric Interchange and the Effect of Structure on Mobility and Equilibrium. Part I. The Three-Carbon System.—K. E. Cooper, Dr. C. K. Ingold, and E. H. Ingold: The Correlation of Additive Reactions with Tautomeric Interchange. Part V. The Structural Conditions Affecting Mobility and Equilibrium.

ROYAL SOCIETY OF MEDICINE (Obstetrics and Gynæcology Section), at 8.—Annual General Meeting.

FRIDAY, MAY 7.

IRON AND STEEL INSTITUTE (Annual Meeting) (at Institution of Civil Engineers), at 10 A.M.—Announcement of the Award of the Andrew Carnegie Research Scholarships for 1926-7.—D. Brownlie: Coal Blending.—W. W. Hollings: Notes on the 'Combustibility' of Coke, and Direct Reduction in the Blast Furnace.—Dr. W. Rosenhain, R. G. Batson, and N. P. Tucker: Effect of Mass in the Heat Treatment of Nickel Steel.—G. R. Woodvine and A. L. Roberts: Influence of Segregation on the Corrosion of Boiler Tubes and Superheaters.—At 2.30.—I. G. Slater and T. H. Turner: The Hardness of Carbon Steels at High Temperatures.—A. R. Page: The Hardening and Tempering of High Speed Steel.—A. E. Cameron and G. B. Waterhouse: The Effects of Arsenic on Steel.—E. D. Campbell and H. W. Mohr: Specific Resistance and Thermoelectro-motive Potential of some Steels differing in Carbon Content.—R. H. Greaves and J. A. Jones: The Ratio of the Tensile Strength of Steel to the Brinell Hardness Number.—H. O'Neill: Deformation Lines in Large and Small Crystals of Ferrite.—A. Osawa: The Relation between Space-Lattice Constant and Density of Iron-Nickel Alloys—T. E. Rooney and L. M. Clark: The Estimation of Phosphorus in Steels containing Tungsten.

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.—H. Baker: The New Delhi.

ROYAL ASTRONOMICAL SOCIETY (Geophysical Discussion), at 5.—Chairman: Dr. J. H. Jeans.—Dr. H. E. Hurst: The Hydrology of the Nile.—H. Harries: The Relation between Barometric Pressure and Gas Pressure in Mines.—Dr. H. Jeffreys: The Reflexion and Refraction of Elastic Waves. The Amplitudes of Bodily Seismic Waves.—R. Stoneley: The Effect of the Ocean on Rayleigh Waves.

ROYAL SOCIETY OF MEDICINE (Laryngology Section), at 5.—Annual General Meeting.

BRITISH INSTITUTE OF PHILOSOPHICAL STUDIES (at Royal Anthropological Institute), at 5.30.—Prof. E. F. Carritt: Contemporary Data for Æsthetics (Lecture).

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Fourth Report of the Marine Oil-Engine Trials Committee.

SOCIETY OF CHEMICAL INDUSTRY (Chemical Engineering Group) (at Florence Restaurant, 56 Rupert Street, W.C.1), at 6.30.—Annual General Meeting.

SOCIETY OF CHEMICAL INDUSTRY (Manchester Section) (at St. Mary's Parsonage, Manchester), at 7.—Prof. J. C. Drummond: Chemical Aspects of Organic Evolution.

ROYAL SOCIETY OF MEDICINE (Anæsthetics Section), at 7.—Annual General Meeting.

PHOTOMICROGRAPHIC SOCIETY (at 4 Fetter Lane), at 7.—Annual General Meeting and Members' Evening.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—A. V. Ballhatchet: Distortion in Wireless Reception.

GEOLOGISTS' ASSOCIATION (at University College), at 7.30.—Dr. D. R. Grantham: The Petrology of the Shap Granite.—G. W. Young: Notes on the Shoshone Valley, Yellowstone National Park, U.S.A. (Lecture).

PHILOLOGICAL SOCIETY (at University College) (Anniversary Meeting), at 8.—Presidential Address.—Prof. D. Jones: The Cardinal Vowels.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir Frederic G. Kenyon: English Illuminated Manuscripts.

SATURDAY, MAY 8.

ROYAL SOCIETY OF MEDICINE (Otology Section), at 10.30 A.M.—Annual General Meeting.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. P. C. Buck: The Song Form in England as represented by Parry.

ROYAL SOCIETY OF MEDICINE (Balneology and Climatology Section) (at Llandrindod Wells).

SUNDAY, MAY 9.

ROYAL SOCIETY OF MEDICINE (Balneology and Climatology Section) (at Llandrindod Wells).

PUBLIC LECTURES.

MONDAY, MAY 3.

UNIVERSITY COLLEGE, at 5.—Prof. G. Dawes Hicks: Hegel's Aesthetics.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY (Royal School of Mines), at 5.15.—Sir T. W. Edgeworth David: Past Ice Ages of the World, and their Control of Animal and Plant Life, with Special Reference to the Australian Evidence. (Succeeding Lectures on May 10 and 17.)

KING'S COLLEGE, at 5.30.—Prof. F. Delattre: La Personnalité d'Henri Bergson et l'Angleterre.

TUESDAY, MAY 4.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, at 5.—Dr. P. Chalmers Mitchell: Logic and Law in Biology (Huxley Memorial Lecture).

UNIVERSITY, BIRMINGHAM, at 5.30.—Sir Oliver Lodge: Difficulties about the Ether (Huxley Lecture).

UNIVERSITY COLLEGE, at 5.30.—Prof. G. E. Moore: Universals and Particulars. (Succeeding Lectures on May 11 and 18.)

GRESHAM COLLEGE (Basinghall Street, E.C.), at 6.—Sir Robert Armstrong-Jones: Physic. (Succeeding Lectures on May 5, 6, and 7.)

WEDNESDAY, MAY 5.

LESSER FREE TRADE HALL, MANCHESTER, at 7.30.—Public Meeting in connexion with the Manchester District Branch of the Electrical Association for Women. Chairman: Principal B. Mouat Jones. Speakers: Miss Ellen Wilkinson, Mr. J. A. Roberts, and Miss C. Haslett.

THURSDAY, MAY 6.

IMPERIAL COLLEGE OF SCIENCE, at 5.30.—Brig.-Gen. H. B. Hartley: Chemical Warfare.