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Preservatives in Foods.

THE difficulty of drawing inferences of value in practical life from experimental work on animals or from observation on man could not be better illustrated than in the vexed question as to the legitimacy of allowing preservatives, especially boron preparations, in human foods. It is known that these preparations, when given steadily and persistently to animals, provoke renal inflammation; it is commonly agreed, notwithstanding occasional medical testimony to the contrary, that they may be irritant to the human alimentary tract, and that they should be barred for young children, for invalids, and for sick persons. It is also agreed that the elimination of a single dose of boric acid is slow, occupying five or six days, and that, therefore, most of us who live in towns are probably never free from boric acid in our systems from youth to old age. It is, furthermore, common knowledge that boric acid or its salts are used largely in cream, butter, liquid eggs, margarine, potted meats, and are dusted over imported bacon and ham; and that a person indulging in a varied diet may not impossibly, day by day, take an amount of boric acid which, even by the defendants of boron preservatives in food, would be regarded as inadvisable, if not actually injurious.

These and like considerations were before the Departmental Committee of 1900 and the more recent committee, the interim and final reports of which were summarised in the issues of NATURE for September 20 and December 13, 1924.

The Committees also had before them the important consideration that the use of boron preparations is not unlikely to foster the continuance of less cleanly processes of food preparation and to conceal incipient and possibly dangerous stages of decomposition of food. In this connexion, it is noteworthy that the prohibition of any preservative in milk has proved most successful, and has doubtless led to increased cleanliness in its production, transport, and storage. It has also been associated with increased use of pasteurisation, which may in some measure permit the continuance of relatively unsatisfactory production of milk; but, even so, pasteurised milk or cream represents a hygienic advance upon boricised milk or cream. It is not surprising, therefore, that the recent Committee recommends that the use of boron preparations as food preservatives should be prohibited; and the Minister of Health has indicated his intention to make draft regulations for this purpose. (For the sake of brevity, boron preservations alone are considered in this article.)

Already there are indications that the proposed regulations will not be universally approved. Sir William Pope, professor of chemistry in the University

of Cambridge, has advanced in the *Times* weighty points for consideration. He regards the evidence of injury by boron preservatives as not convincing, and stresses the complexity of factors involved in human experimentation with such preparations, owing to the diverse factors concerned in the balance of health and disorder. Similarly, Dr. R. Hutchinson writes stating that if injury from such preparations occurs, "it has entirely escaped the notice of medical men." Also, Prof. F. W. Tunnicliffe considers that in deciding against the use of boric preservatives "*a priori* argument has been drained to its dregs," and inadequate attention has been paid—as Sir William Pope had already suggested—to the danger of dearer and scarcer food, as the result of the prohibition of preservatives for perishable foods needing to be transported long distances. At the least it appears to be suggested, let us postpone the prohibition of boric preservatives until the mass processes of production and transportation of perishable food have become perfected. Great waste of food is avoided by mass production. Mass production is indispensable under modern conditions of life; and the means of transport within Great Britain do not permit, it is urged, even if those from other countries permit, of cold storage and transportation, to an extent which will avoid much waste of valuable food, if preservatives are forbidden.

As indicating the way in which politics may influence hygienic control, it is suggested that the prohibition of boric preservatives in Germany is, in part at least, enforced in order to keep out Canadian and American bacon and ham. The same effect might follow from a similar prohibition in Great Britain; and so we have illustrated the struggle and conflict of motives and aims which almost necessarily arise when any reform which is theoretically desirable is proposed. Motives of preferential trading may arise, the plea is entered that the proposed action will involve the wasting of much perishable food, and it is contended—as may easily be done—that the evidence of injury from the preservatives proposed to be prohibited is dubious and may even be non-existent.

These are reasons for proceeding cautiously, and there need be no extravagant fear that the Ministry of Health will proceed otherwise. But that the use of chemical preservatives is undesirable is, we think, indisputable; that their restriction and their extended restriction should be enforced, follows as a desirable reform; and in our view this restriction is not likely to be followed by increased scarcity of food, for we have every confidence in the ability of those concerned to improve their methods of manufacture and of transport, so as to obviate the need of any preservative except cold.

In deciding a complex practical problem like this, we are bound to consider the weaker members of the community, for whom doses of boric preservatives not producing recognisable symptoms in the majority, are likely to be serious, and this consideration alone suffices, we think, to justify extension of the present regulations against food preservatives in the direction recommended by the recent Departmental Committee. It has been urged that in this connexion Solon's advice to the Athenians should be followed: Have the best laws that can be kept, not the best laws that can be made. But past experience has shown that gradually increasing stringency in regulating food preservatives can be enforced, and that it is associated with better processes of preparation and transportation of food; and the next steps in this direction may be expected to have similar results.

Philosophical Biology.

(1) *The Study of Living Things: Prolegomena to a Functional Biology*. By Dr. E. S. Russell. Pp. xx+139. (London: Methuen and Co., Ltd., 1924.) 5*s*. net.

(2) *The Passing of the Phantoms: a Study of Evolutionary Psychology and Morals*. By Prof. C. J. Patten. Pp. 95+4 plates. (London: Kegan Paul and Co., Ltd.; New York: E. P. Dutton and Co., 1924.) 2*s*. 6*d*. net.

(3) *Tantalus: or the Future of Man*. By Dr. F. C. S. Schiller. Pp. 72. (London: Kegan Paul and Co., Ltd., 1924.) 2*s*. 6*d*. net.

As the reading public gradually accepts the doctrine of evolution and its corollary, the unity of life, a demand arises for books which deal, on one hand, with the application of biological methods and ideas to human life, and on the other, with an analysis of those ideas. With the narrowing of the gulf between man and the other animals, we find a quite legitimate tendency to interpret the mind of animals in terms of the human mind, and conversely. But such a procedure demands enormous caution, and one can scarcely hope to find the necessary critical attitude in books which are written to defend a point of view rather than to examine all sides of a problem. Yet they may justify themselves if they are sufficiently stimulating or attractive.

(1) Dr. Russell's book deals with the various methods by which biological problems may be attacked. After a passing reference to the purely morphological point of view, he briefly examines and rejects the materialistic conception of life, and points out its failure to explain the unity of the organism. Vitalism, that is, the theory that an organism consists of inert matter plus a soul or entelechy, is shown to have its own difficulties without solving those of materialism. So far Dr. Russell is in agreement with J. S. Haldane, whom

he quotes at length. But he regards Haldane's position as essentially a half-way house, also tenanted by J. B. Watson, to his own psychological outlook. "I know myself," he says, "as a psycho-physical unit or individuality, not as an immaterial entity acting upon an external material object, my body." It is from this point of view that he considers the behaviour of other organisms as exemplified not only by movement and secretion, but also by such activities as growth. The latter half of his book is taken up with the attempt to apply this view in detail. For example, it is suggested that the growth-regulating secretion of the thyroid gland "acts not directly by virtue of its specific chemical constitution, but indirectly by virtue of its meaning or significance, being perceived or sensed in an elementary way by the organs and responded to in the functional or psychobiological sense."

Apart from his complete neglect of such difficulties for a monadistic view as are presented by fission or conjugation, for example, we are inclined to regret that Dr. Russell does not push this point of view to its logical conclusion. From a strictly psychological point of view he has no business to talk about internal secretions, and adrenaline, for example, is not an aromatic amine from his point of view, but simply an element in certain emotional states. As it is, we feel that he tends to use physics and chemistry so long as they suit him, and adopts a psychological point of view when the complexity of the physico-chemical situation becomes intolerable. But few biologists achieve consistency in their hypotheses, and we can recommend Dr. Russell's book to all who are interested in the philosophical side of biology.

So far man has only learned to think on two lines, one which enables us to deal with our fellow-men and the higher animals, the other with inanimate objects; but it does not follow that these are the only possible types of thought. Perhaps some intermediate outlook, which preserves the unity attributed to the human individual though without his memory or foresight, may prove valuable in dealing with lowlier organisms or with our own unconscious behaviour.

(2) Prof. Patten's book, after a thumb-nail sketch of evolution, plunges into animal psychology; and human attributes, such as admiration, imagination, and superstition, are assigned to birds and mammals. The bearing of animal on human psychology is discussed, with special reference to the origin of human superstitions, which include all beliefs in supernatural beings. The book makes no attempt to be either scientific or exhaustive, but it is so charmingly written that we believe it will find many readers. It is clear that the author is a real lover of animals, and if his love leads him into a perhaps unduly confident belief that they are on the whole virtuous and happy, it inspires a number of delightful anecdotes of animal behaviour. His religion, a sunny rather than philosophical pantheism, springs directly from his love of Nature. There is little that is novel in the book, but the author's point of view is worth restating from time to time. As a means of bringing home the reality of evolution to the average child of sixteen or so, we feel that it might be of real value in school libraries.

(3) "Tantalus," who here represents humanity as a whole, is a philosopher's reaction to biology. The reaction is sometimes rather naïve, as when he pauses to wonder that from the biological point of view man has not evolved in the last thirty thousand years. Critics of their fellow-creatures, and particularly of the present Government, would do well to remember Lingula, which has scarcely changed in the three million or so centuries that have elapsed since Ordovician times. Dr. Schiller very rightly stresses the fact that in our society those social classes which we admire most are reproducing themselves most slowly, but some of the reasons given for this fact are, to say the least, unconvincing. For example, the author alleges that the advance of medicine has enormously diminished selective mortality and improved the chances of weaklings to survive and leave descendants. The contrary case could be argued, for in the last two centuries epidemic diseases such as smallpox have almost disappeared, and more chronic complaints such as tuberculosis, which kill far less indiscriminately, have remained with us. The question whether the differential birth-rate may not be due to certain economic features of our civilisation rather than to its philanthropy and hygiene is scarcely considered.

With regard to the traditions which constitute man's non-biological inheritance, Dr. Schiller is equally gloomy. Perhaps it is a too intimate acquaintance with compulsory chapel and university examinations which prompts him to ask, "How many religions have perished from ritual sclerosis, how many sciences have not been degraded into pseudo-sciences or games?" He suggests two ways out of the impasse, one being the practice of Christian ethics, the other of eugenics. He believes that history has shown that humanity as at present biologically constituted will not accept the former. He has more hope of the latter, provided we realise that our whole procedure is essentially experimental. He has also some confidence in the future of applied psychology. The scientific reader who is interested in the reaction of biological ideas on the mind of an intelligent outsider, or wishes to see the case for eugenics briefly stated without the display of too much class or racial prejudice, would do well to buy this little essay. J. B. S. H.

The Study of Agricultural Economics.

(1) *Elements of Land Economics.* By Dr. Richard T. Ely and Edward W. Morehouse. Pp. xviii+363. (New York: The Macmillan Co., 1924.) 17*s.* net.

(2) *Introduction to Agricultural Economics.* By Dr. Lewis Cecil Gray. (Social Science Text-Books.) Pp. xii+556. (New York: The Macmillan Co., 1924.) 12*s.* net.

(3) *Elements of Rural Economics.* By Prof. Thomas Nixon Carver. Pp. v+266. (Boston and London: Ginn and Co., 1924.) 7*s.* net.

(4) *Farm Accounts.* By C. S. Orwin. (Cambridge Farm Institute Series.) Second edition, revised. Pp. vi+140. (Cambridge: At the University Press, 1924.) 5*s.* net.

(5) *A Short System of Farm Costing.* By H. R. J. Holmes. Pp. 107. (London: Oxford University Press, 1924.) 6*s.* 6*d.* net.

(6) *Farm Accounting.* By Prof. E. L. Currier, Prof. N. J. Lennes, and Prof. A. S. Merrill. Pp. ix+287. (New York: The Macmillan Co., 1924.) 7*s.* net.

MEN of science, in the first instance dubbed "Improvers," have been continuously at work for at least a century and a half investigating such problems as those involved in animal- and plant-husbandry, manuring, and the mechanics of agriculture. Systematic study of the other, or economic, side of the industry has been undertaken only within the last decade. Research work under this head may imply the compilation of elaborate cost-accounts, comparison of various methods of farming, investigation into the pros and cons of large or small-holdings or the distribution of various forms of land-tenure, inquiry into the profits accruing to each class of person engaged in the industry, study of marketing systems, and so on. Into each of these fields individual workers have gone before, but that all-important factor, continuity of effort, has, until recently, been lacking. It is, for example, possible to recover the most elaborate records of the working of particular manors more than six hundred years ago; in the seventeenth century Henry Best minutely investigated what we should now describe as the "economy" of North-country farming; a hundred years ago, full statements of farm accounts kept in Norfolk and other arable counties were published.

Generally, the efforts of those responsible for these pioneer investigations were ridiculed; at best they were made the subject of acute controversy. For example, in Scotland, the publication in 1823 of an article "showing the expense and value of the produce of a Lothian farm during the late war" was thus welcomed by an anonymous farmer: "Try Mr. Scott's statement by what standard you may, and inform me wherein consists its merits. If it be considered a production of imagination, or of reflection, it is inferior to a nursery tale; as a work of instruction, or of utility, it is fallacious and ill-judged; as a statement of Lothian husbandry it is little short of a libel." Again, an eighteenth-century advocate of small farms thus delivered himself to a pamphleteer on the opposite side: "The fiend who wrote this was in all probability never beyond the stench of the infernal abode wherein he dwells!"

If controversies are still engendered on the latter subject, and apathetic reception upon occasion rewards the efforts of Mr. Scott's successors, there is no doubt that the vast majority of agriculturists appreciate that there exists nowadays a new, and possibly valuable, means of approaching rural problems. In Great Britain, since the War, successive Governments have granted increasing sums towards the extension and maintenance of services charged with investigational and advisory duties. Nor is interest confined to this country, for, judging from reports emanating from Japan, the United States, Switzerland, and Denmark, it may be confidently stated that the movement towards a closer study, and therefore a better understanding, of farming conditions and rural economics is widespread. A natural corollary is the appearance of numerous publications, either dealing with the history and general principles of the subject, or confined to particular sections. In both classes the United States is well represented.

(1) The first book on our list comprises an elaborate analysis of the utilisation of American soil. Its authors have produced a work which is bound to be of considerable value to American students, and one that is very suggestive to those European readers who are interested in the problems raised during the transition of a vast territory from a natural condition to a state aptly illustrated by the frontispiece, entitled "Airplane view of Manhattan Island, New York City." The distribution of the various categories of soil is well described, and successive chapters deal with its utilisation, for his varying requirements, by man, his access to forest and mineral products, and the provision of credit; they also touch on what are to us such familiar and vexed questions as the taxation of "increments in land values." The volume is well produced and contains excellent diagrams and illustrations, but it contains scarcely any reference to conditions existing elsewhere.

(2) Dr. Gray's book is of more general interest to European readers. The author is an official of the United States Department of Agriculture, and he has produced a book which covers a wide field, ranging

from the enunciation of general economic theories down to advice on the marketing of fruit. He does not disdain reference to conditions existing in other countries, and his views on numerous rural problems will be read with respect by students therein. His twenty-six chapters all conclude with "Questions on the text," which do not detract from their value, but tend to emphasise the American origin of the work itself. The diagrams are excellent; particular praise must be given to the maps, produced by the author's own Department, showing the distribution of crops and of different-sized farms, a form of activity in which Great Britain has hitherto lagged behind the United States; fortunately, however, within a short time matters will have been rectified in this respect. Dr. Gray's work is admirably produced, and its moderate bulk is disproportionate to the number of its pages.

In (3) is found a work from the pen of a professor of political economy, which, to British ideas, is more orthodox in its treatment of the subject. The general history of agriculture is not neglected, for reference is made to village communities and the manorial system, and the names of certain English writers of long ago are mentioned. The author exercises considerable restraint when dealing with such contentious questions as co-operation and land-tenure, and has always at hand appeals to economic laws to enforce his arguments. He has produced a small, but scholarly, work which will not only be read with interest by British economists, but will also be retained on their bookshelves. Diagrams similar to those above referred to are again prominent.

(4) Mr. Orwin is undoubtedly the recognised authority on farm accounts in Great Britain, and it is largely through his persistent efforts during recent years that the great advantages to be obtained from the accurate keeping of "costings" has gained wider recognition amongst the farming community. In the latest edition of his book will be found clearly mapped out the procedure to be followed in farm costing. The author has enumerated the various principles involved in a straightforward way which should make the volume of the greatest use to farmers and students who have had no very great experience in book-keeping. The underlying principle to be grasped is that the balances of the apparently unproductive accounts (for example, labour, rent, foods, and manures) are charged against the productive accounts in the proportions in which the latter have benefited from them. This involves the keeping of records of labour, both manual and horse, and of rations fed to stock. Mr. Orwin gives examples of appropriate labour and ration sheets, and explains the method of their analysis; complete and up-to-date cost accounts of a Gloucestershire farm add to the value of the latest edition of what is admittedly a standard work in its subject.

Mr. Holmes in (5) has somewhat missed the aim of his endeavour to maintain simplicity as the primary object in preparing this volume. Those farmers for whom his book is intended as a guide will be inclined to give up the task of trying to master costing principles when they read that not only must a record be kept of the number of days grazed by each class of stock, and these eventually converted into "sheep equivalents," but also that the manurial residues of foods fed on pastures must be calculated. It is not to be denied that such records can be kept with advantage on certain types of holdings, but on small farms, and where live stock is of diverse types and ages, it is questionable whether the degree of accuracy with which such information could be compiled would warrant the laborious calculations involved. Mr. Holmes advocates the "Standard" method of valuing cows and breeding stock. In this he is undoubtedly right, as in times of fluctuating prices, paper profits and losses are thus eliminated. The volume contains a full set of accounts for the year 1920–21 on a dairy farm of some two hundred acres.

As a text-book designed for school study in the United States, (6) can be recommended on account of the large number of exercises and "Topics for discussion" appended to each chapter. The first part deals with methods of making an inventory and financial statement, the second is confined to financial accounts, while the third deals with cost accounts and methods of recording data. As a treatise for British readers it is of interest in presenting arguments in favour of the adoption of general principles other than those commonly recognised in this country. Some of those advocated are open to criticism. For example, the authors recommend that interest on the average investment of capital in each branch of the farm should be charged against its cost, and also that a charge should be made against cost for the value of the farmer's own labour. Again, in regard to home-produced foods fed on the farm, they state that "an intermediary product which may readily be marketed should be charged at its farm value and not at its cost of production. Other intermediary products should be charged at their cost of production." The accepted practice in Great Britain, that of charging all intermediary products at cost price, appears to be much the sounder of the two methods. The volume contains cost accounts typical of conditions in Kansas and Iowa. American currency, however, and such expressions as "chores," "shelling," and "snapping corn" render them of doubtful utility outside the continent of North America.

J. A. VENN.

The Chemistry of Flour Milling.

Modern Cereal Chemistry. By D. W. Kent-Jones. Pp. ix+324. (Liverpool: The Northern Publishing Co., Ltd., 1924.) n.p.

THE chemistry of wheat flour, and the elucidation of the factors influencing the "strength" or baking quality of flours from different wheats, present problems as complicated and difficult as any to be found in food chemistry. Recent research has thrown much light on some of these problems, and the author, who is well known as an authority on flour chemistry, is to be congratulated on having given a connected and critical account of the important work done on this subject during the last few years.

The English miller draws his wheat from almost every wheat-producing country in the world. Many of these wheats differ enormously in their strength or ability to produce a good loaf; that is to say, a large well-risen loaf possessing a certain silky and finely vesiculated texture. The author, in his chapter on the colloidal chemistry of flour, discusses the relative importance of various factors in the production of strength. The actual amount of gluten present and its physical character, the degree of colloidal dispersion of gliadin and glutenin, the hydrogen ion concentration of flour and the extent to which it is "buffered," the enzymic activity of the flour and the relative amount of yeast food present, are all more or less concerned in determining strength or weakness in a flour. The author is clearly on good terms with the most recent work on the colloidal chemistry of flour, and has given in this chapter an able review of present-day knowledge in this field.

It is when the author comes to the chapter on bleaching and flour improvers, on p. 165, that he treads heavily on dangerous ground. He adopts wholeheartedly the attitude that the artificial bleaching and improving of flour by nitrogen peroxide, chlorine, nitrogen chloride, peroxides, persulphates, acid phosphates, etc., is completely justifiable and beneficial both to the trade and to the consumer. In fact, he is at such pains to emphasise the entirely harmless character of these additions that the suspicions of the reader may well be aroused, and he may be led to inquire more closely whether the introduction of one pound of pure chlorine gas into a ton of flour is, in fact, entirely without effect on the consumer's health, whether there may not be some subtle action on the flour, affecting, ever so slightly, those vital principles which food manufacturers are never tired of claiming for their products, and whether the oft-repeated argument that no one has ever been able to prove injury to health from such additions is good enough where the most important foodstuff of all is concerned. To attempt an answer to these questions would, however, be outside the province of a reviewer.

The concluding chapters dealing with conditioning, moisture in wheat and flour, and analysis of flour are excellent. The book may be warmly recommended to all interested in the chemistry of flour, on the understanding that the Report of the Departmental Committee on the Use of Preservatives and Colouring Matters in Food be glued to p. 165. G. W. M.-W.

New Measurements of Atomic Masses.

Isotopes. By Dr. F. W. Aston. Second edition. Pp. xi+182+5 plates. (London: E. Arnold and Co., 1924.) 10*s.* 6*d.* net.

IT is seldom that a natural philosopher has made a subject so peculiarly his own as Dr. Aston has done with the experimental investigation of isotopes. At the present time, about fifty non-radioactive elements have been examined for isotopes, and all except half-a-dozen or so are among Dr. Aston's trophies. It is not, apparently, so much that other workers have stood aside as that the technique is not quite so simple as a casual description of the experimental method might suggest to the inexperienced. About two years ago, Dr. Aston published a general account of his work since the War under the title "Isotopes," and, as was to be expected, a second edition was soon demanded, which has now made its appearance.

As reference to the table of isotopes on p. 107 will immediately show, in the interval of two and a half years, more than twenty new elements have been investigated for isotopes by the author, so that at the time of writing, all the elements from atomic number 1 to atomic number 39 have been worked through, and many in the range 39 to 80. A beginning has been made with the elements of the rare earth group. The additions are mainly due to the development of the method of accelerated anode rays by the author. A salt of the metallic element to be investigated is made into a paste with graphite, and this paste, packed into a small tube, is used as the anode, and bombarded with cathode rays. The instability of the discharge consequent on the release of gas from the anode is avoided by a skilful device consisting of a subsidiary cathode and a kenotron valve. It is indicative of the troublesome nature of the work that even Dr. Aston himself records that when the apparatus was working sweetly, he analysed six elements successfully in as many working days, but that after it had been dismantled and set up again so as to be, apparently, exactly the same as before, he was unable to obtain any results of value for some weeks. When conditions are favourable the method gives excellent results.

The accuracy which Dr. Aston now obtains in his measurements is emphasised by the fact that he is able to direct attention to a departure from the whole number rule shown by certain isotopes, notably those of tin. This departure of the atomic mass from a whole number (oxygen, of course, being taken as 16) amounts to only two or three parts in a thousand, yet seems to be definitely established. It does not appear possible at present to draw any very precise conclusion from this observation. To avoid disturbing our ideas the effect may be attributed, in a general way, to some "close packing" of the same kind as prevents the masses of the general isotopes being whole numbers in terms of hydrogen as unity, but so little is known of the structure of complex nuclei that this is, in effect, simply a shelving of the matter until further measurements, of even higher accuracy, shall become possible. The few cases of departure do not appear as such in the tables of isotopes, since a new term, "mass number," has been introduced in place of the old "mass of isotope." This is defined either as the number of protons in the nucleus or as the nearest whole number to the mass expressed in terms of oxygen as 16: both definitions amount to the same thing. Since the departure is a minor matter, at any rate in the present state of our knowledge, this term is a timely one which serves, as good terms should do, to avoid inaccuracy on one hand and circumlocution on the other.

The book contains many references to relevant results of other researches which have been carried out in the last two or three years, such as the work of Rutherford and Chadwick on nuclear disintegration, and the investigations of Ellis on nuclear γ-rays. A rather fuller account of Fajans' speculations on relative stability of nuclei might have been welcome, since they are both more intelligible and more fruitful than most of the conjectures on this subject. The detection of an isotope effect in band spectra is also discussed, but, it may be said, it is by no means certain that the boron nitride bands of Jevons, on which there has recently been discussion in the correspondence columns of NATURE, are really monoxide bands, as Mulliken wants them to be, theoretically desirable as it may be for them to be so.

The paper on which the second edition is printed is a great improvement on that of the first, and it is pleasant to be able to acknowledge, in these dear days, that the book is very reasonably priced. In place of a final word of commendation, which is superfluous in this case, may be ventured the anticipation that in another year or two Dr. Aston will bring out a new edition recording the remaining thirty or so non-radioactive elements as satisfactorily sorted out into their isotopes. It seems very probable. E. N. DA C. A.

Our Bookshelf.

The Year-Book of the Scientific and Learned Societies of Great Britain and Ireland: a Record of the Work done in Science, Literature and Art during the Session 1923–1924 by numerous Societies and Government Institutions. Compiled from official sources. Forty-first annual issue. Pp. vii+405. (London: C. Griffin and Co., Ltd., 1924.) 15*s.* net.

THE issue of this Year-Book for 1922–23 did not appear until the summer of 1924: this was somewhat late for a reference book dated for 1923. The publishers deserve our gratitude, therefore, for the promptness with which they have produced the volume for 1924. This forty-first issue has already started on a career of usefulness in our hands, which will continue until, and even after, the volume for 1925, which we hope to see in due course, has been published.

Compared with last year's Year-Book, that for 1924 has been increased by sixteen pages, and we understand that seven societies have been added to the list. The increase affords some measure of the steady and healthy progress of scientific thought in Great Britain. As usual, the entries are grouped conveniently according to subject, and in each group there is a further subdivision into societies in London, the provinces, Scotland, and Ireland. Under each entry is included the address, officers, meetings, conditions of membership, and publications of the society or institution in question, and in many cases the titles of papers read during the session 1923–24 follow. Valuable summaries of the work during the year of such public institutions as the Royal Observatory, Greenwich, the National Physical Laboratory, and Rothamsted Experimental Station are also given. Our thanks should be added to those of the publishers to the officials whose replies to requests for detailed information have made it possible to issue such an "official" volume. It was probably too late for insertion that the new address of the Royal Dublin Society at Ballsbridge, Dublin, was announced.

In turning over the pages, we have found the British Photographic and the British Cast Iron Research Associations (the former not indexed), but none of the score or so of the remaining industrial research associations. The volume as it stands is, however, a valuable work of reference, which all who would keep in touch with scientific movements in the British Isles would do well to have at hand.

Auxiliary Tables of the Survey of India. Fifth edition. Revised and extended by Dr. J. de Graaff Hunter. Part 1: Graticules of Maps. Pp. 25. (R. 1=2*s.*) Part 2: Mathematical Tables. Pp. xiii+89. (Rs. 2=4*s.*) Part 3: Topographical Survey Tables. Pp. xxi+52. (Rs. 1.8=3*s.*) (Dehra Dun: Trigonometrical Survey; Part 1, 1921. Part 2, 1924. Part 3, 1923.)

THE work of the Survey of India, especially in the domain of geodesy, has a world-wide reputation. The first edition of these tables, which are intended to facilitate calculations connected with survey operations of all kinds, appeared so long ago as 1868. They have more than once been copied and adapted by the surveys

of other countries, though, of course, they are primarily intended to apply to the methods and scales used by the Survey of India.

Part 1 contains tables for the projection of maps falling within the latitudes embraced by India: on the polyconic projection, which is that employed for the larger scale topographical maps; on the modified secant conical for small scale and general maps; and a table for the projection of the sheets of the *Carte International*, on the millionth scale, of which India has produced so many sheets. Part 2 displays a series of mathematical tables in general use in survey operations, also metrical equivalents; mathematical and physical constants; geodetic data (fundamental coordinates adopted by the Survey of India); and, at the end, a few pages of useful mathematical formulæ. Part 3 comprises a set of tables covering all the ground required by the topographical surveyor in his triangulation and astronomical work in the field.

These tables are a considerable advance on the previous editions, and Dr. Hunter deserves great credit for the way in which they have been presented. They have been prepared most carefully so as to assist in the solution of almost any problem with which the surveyor is likely to be confronted. The plan of publishing each part separately has added very much to their convenience for use in the field or office.

Part 4, Geodetic Tables, is under compilation, and may shortly be expected; while Part 5, explaining the forms and formulæ in use in the Survey of India, is in contemplation. The parts already issued contain full explanations of the tables, and also, in most cases, examples showing how the tables are used in practice.

H. L. CROSTHWAIT.

Travaux pratiques de physique générale: exécutés à l'Institut de Physique de la Faculté des Sciences de Strasbourg en vue du certificat d'études supérieures de physique générale. Par Prof. H. Ollivier. Première série: Sujets de 45 manipulations, réparties en 30 séances de 4 heures. Pp. 104+9 planches. (Paris: J. Hermann, 1924.) 12 francs.

PROF. OLLIVIER'S "Cours de physique générale" has already been the subject of favourable notice in these columns. The present volume on advanced practical physics maintains the high standard we have been led to expect from the professor of physics of the University of Strasbourg. It forms the first part of a treatise on the subject, and contains an account of those experiments which are repeated each year by all students attending the advanced course. It is assumed that the student has already attended an elementary laboratory course, is familiar with the theory of many of the instruments, and has a fair knowledge of mathematics. Classical experiments predominate in this first volume, and the apparatus used is carefully constructed and tested. Many of the instruments described are expensive, and students are expected to use them with the utmost care and to obtain results of a high degree of accuracy.

The experimental hints and cautions given in the text are most valuable, and all teachers will appreciate the "recommendations générales," prominently displayed early in the course: "Il ne faut toucher avec les doigts ni les parties graduées des appareils, ni les verniers, ni les poids de précision, ni les pièces optiques: lentilles, miroirs, nicols, lames quart d'onde, etc." Amongst the experiments we note with special interest Rowland's method of determining the mechanical equivalent of heat, the use of the stroboscope, photography, including photography in colours by the Lumière process (in this case no directions are given), a study of elliptically polarised light (arranged by M. G. Foëx), magnetisation of an iron ring using a fluxmeter, and the behaviour of a three-electrode lamp. A novel and interesting feature in a text-book of practical physics is the series of nine plates containing excellent photographs of the Institute of Physics of the Faculty of Sciences of Strasbourg and of the apparatus arranged for experimental work in the laboratories.

H. S. A.

An Introduction to the Study of Cytology. By Dr. L. Doncaster. Second edition. Pp. xiv + 280 + 24 plates. (Cambridge: At the University Press, 1924.) 21*s.* net.

IT is not always that literary ability and scientific method are wed together in sufficient degree to produce a sound scientific text-book which is, at the same time, of literary merit. In recent years few famous biologists have possessed both these qualities in greater degree than the late Prof. Leonard Doncaster. It is, therefore, with special pleasure that we welcome the appearance of a second edition of his well-known book on "Cytology."

A monograph on any highly specialised branch of study has one great advantage over a work produced by the collaboration of a number of authors in that it possesses a greater unity of purpose, as the conception of a single mind, than could be produced by the most successful team work. In this respect all must admit that Prof. Doncaster's book is pre-eminent. But to maintain this quality becomes a most serious difficulty to the editor of a posthumous edition. This Mr. Grey has admirably overcome, and, although introducing much new and useful material, has in no way detracted from the arrangement and theme of the book as a whole.

The book would have been improved, perhaps, if more space had been given to the recent extensive advances in our knowledge of the cytoplasmic inclusions. Further, we cannot help feeling that much too little space is devoted to a consideration of the various types of cells of the soma of higher forms, for almost the entire book is concerned chiefly with the reproductive processes of gametogenesis, fertilisation, and segmentation.

The production of the volume is excellent, and we are pleased more especially with the illustrations. We consider the edition a well-written and instructive text-book for the student and research worker.

F. W. ROGERS BRAMBELL.

A School Chemistry. By O. J. Flecker. Pp. viii+238. (Oxford: At the Clarendon Press; London: Oxford University Press, 1924.) 3*s.* 6*d.* net.

AMONG the minor compensating advantages of the War period was the check given to the ever-rolling stream of text-books on elementary science, but now that paper and printing are less costly, the tide appears to be rising again; let us hope it will not overwhelm

us. The young and aspiring teacher may be commended for his zeal in writing a text-book for his own use—authorship invariably impresses a literary headmaster and a governing body—but it is a question whether his time would not be better spent experimenting in the laboratory and in keeping well abreast of modern developments. It is another matter if he has something really novel to say, or some new method of arrangement or presentation. Unfortunately, however, originality seems to be somewhat elusive since the salad days of Ostwald, Alexander Smith, and Armstrong, and the present little work, like scores of others, does not excel in this respect. The book has its merits; it is well written and particularly well spaced; the explanations are clear, and there is very little to criticise on the score of choice of experiments or of accuracy (but *any* chloride would not do instead of salt for making hydrogen chloride, p. 94). The main defect is a too strict adherence to the old-fashioned, cookery-book style; the pupil who believes all he is told in this book, and performs religiously the rites prescribed, will certainly learn much that is useful and interesting, but they will not help him to acquire or develop the scientific habit of mind, a possession of far greater value than a passive knowledge of the *minutiæ* of chemical change.

Contributions from the Jefferson Physical Laboratory and from the Cruft High-Tension Electrical Laboratory of Harvard University for the Years 1922 and 1923. Vol. 16. 47 papers, unpaged. (Cambridge, Mass.: Harvard University, n.d.) n.p.

THIS volume covers a rather longer period than is indicated in its title, the earliest paper dating from February 1921 and the latest April 1924. Ten of them are by Prof. Bridgman, and deal with the properties of materials under high pressure, and several of these have been noticed in our columns. Eleven others are due to G. L. Clark, National Research Fellow, and Prof. W. Duane, and deal mainly with X-rays and their use in crystal analysis. In their method of investigating crystals the continuous spectrum of X-rays between 0·12 and $0{\cdot}80 \times 10^{-8}$ cm. is utilised, and this allows of the use of an ordinary X-ray tube with tungsten target run at a high voltage. The substance examined may be a single crystal or a powder. The wave-length of a ray which is reflected at a given angle from the material is calculated from the quantum equation $Ve\lambda = hc$, where V is the least voltage applied to the tube which will cause it to emit the line λ, e is the electronic charge, h Planck's constant, and c the velocity of light. The tube being run from a storage battery, V can be determined accurately. Prof. Lyman contributes three papers on a new vacuum spectrograph and the extreme ultra-violet spectrum.

The volume maintains the high standard established by its predecessors and shows that Harvard believes in extending as well as imparting knowledge.

Beach Grass. By C. W. Townsend. Pp. xii+319+42 plates. (Boston, Mass.: Marshall Jones Co., 1923.) 3.50 dollars.

THE reader who expects under this title to find a dissertation on *Psamma arenaria*, the marram grass of the coasts of the British Isles, will be disappointed, for the plant is scarcely mentioned. But the book is well worth reading. It is a breezy, refreshing account of many aspects of Nature on the sand-dunes that form the coast line in the neighbourhood of Ipswich, Essex Co., Massachusetts, U.S.A. The author is a naturalist in the widest sense of the word, and has here set down a number of observations, illustrated by some admirable photographs, that will interest alike the serious student of physical geology, the ornithologist, the forester, and indeed all whose scientific tastes take them into the open air. The description of the ice-bound sand-dune coast, and the effects of frost both on the shore and on the sea itself, and the bizarre scenery produced and most successfully illustrated, are truly wonderful. In the chapters dealing with birds, biologists will find some shrewd remarks on sexual selection, and interesting accounts of the courtship of many species of birds. Incidentally there are quoted authentic examples of the economic value of several birds of prey and of some of the insectivorous birds. The book would perhaps be of more direct use to the British reader if the scientific names of the birds were inserted: the popular American names are not very familiar on the eastern side of the Atlantic.

Reason and Morals: an Enquiry into the First Principles of Ethics. By Dr. Israel Levine. Pp. xi+177. (Glasgow: MacLehose, Jackson and Co.; London: Simpkin, Marshall and Co., Ltd., 1924.) 6*s*. net.

THE author received the degree of D.Litt. from the University of Glasgow for this thesis, and though primarily dealing with a subject of philosophy, it is of peculiar scientific interest. The moral law is generally held up to wonder and veneration as something utterly unintelligible on ordinary scientific principles, indicating a supernatural origin and bearing witness to a divine purpose in individual lives. Dr. Levine, in a clear and trenchant argument, sweeps this whole conception away. The moral law is shown to be the simple condition on which human society can exist. Without morals common life is impossible, and without common life the survival of the human species is impossible. The existence and maintenance of social life are the inevitable expression of the life-impulse itself. The essay concludes with a brief historical survey, in which it is claimed that the rational tradition in moral theory has received in modern times its complete vindication in the discoveries of psychology.

Die Grundgedanken der Machschen Philosophie: mit Erstveröffentlichungen aus seinen wissenschaftlichen Tagebüchern. Von Prof. Dr. Hugo Dingler. Pp. 106. (Leipzig: J. A. Barth, 1924.) 3 gold marks.

AN excellent short account of the leading thought and ground-principle of the most philosophically minded of the German physicists. When only fifteen, he had read from his father's library Kant's "Prolegomena" and Fechner's "Tagesansicht," and he seems even then to have formed a fixed resolution to eschew metaphysics and follow in all his researches a pure inductive method. He had throughout his life an almost English aversion to apriorism and to transcendental systems of philosophy. The book contains a most interesting selection from his note-books from 1880 to 1882 with memoranda for his "Mechanik." It recalls the "Common-place Book" of our own Berkeley.

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 Future of the Meteorological Office.

IN the note on Mr. C. J. P. Cave's presidential address to the Royal Meteorological Society (NATURE, January 31, p. 168) Mr. Cave is quoted as saying: "It is true that there is the Meteorological Office, but its position at the present time is an unfortunate one; its future is uncertain. In the past the Meteorological Office was directly under the Meteorological Committee, which administered a Government grant. Soon after the War, the Office was placed under the Air Ministry. It seems a grave anomaly that the Meteorological Office, which deals with problems of the greatest importance to many Government departments and to many public bodies, should be solely under the direction of the Air Ministry, more especially when there is in the Department of Scientific and Industrial Research a very suitable body under which it might have been placed."

Although I am sure Mr. Cave would not wish this to be taken as anything more than his own personal opinion, I must ask you to allow me to say that I do not share it. Far from the Meteorological Office being in an unfortunate position, it is fortunate in being able to command, under the Air Ministry, many facilities which no other Government department could give. The well-organised wireless service of the Air Ministry, with its powerful station at Kidbrooke, is available for the exchange of those wireless messages on which national and international meteorology now depends. Aeroplanes are placed at our disposal to obtain observations from the upper air, and this would be quite impossible if we were not closely connected with the Royal Air Force and the Royal Aircraft Establishment at South Farnborough.

I do not understand what Mr. Cave means when he says "its future is uncertain." It is true that the Meteorological Committee formerly administered a Government grant, but that grant was only 20,000*l.* before the War, while the meteorological expenditure now borne on Air Votes is more than 100,000*l.* The Air Ministry necessarily exercises financial supervision over this expenditure, but I have no reason whatever to complain of the result. In so far as the Treasury intervenes, this is an inevitable concomitant of the appropriation of money from public funds and is applicable to all voted services alike, whether administrative or scientific.

Flying, especially civil flying, is so dependent on a good meteorological service that if the Meteorological Office were not under the Air Ministry, there would have to be a separate meteorological service for aviation. Only those who have had to organise the existing complicated meteorological service for aviation with its thirteen stations on aerodromes and hourly messages along the Croydon-Continental routes can realise the close connexion necessary between the Meteorological and other departments of the Air Ministry.

Because the Meteorological Office deals with problems of the greatest importance to many Government departments and to many public bodies, the Meteorological Committee has been retained to advise the Air Council on matters relating to the Meteorological Office. This Committee, on which there are representatives of the Royal Society, the Royal Society of Edinburgh and six Government departments, is by no means without influence on the policy of the Meteorological Office. The Committee takes special interest in the scientific work of the Office, and one representative of the Royal Society is ex-officio vice-chairman. This alone would be a guarantee that the scientific work is well maintained. As a matter of fact, we have more staff engaged on purely scientific work than ever before, and I am proud of the number of papers which are published yearly by my splendid scientific staff.

After four years' experience as Director of the Meteorological Office under the Air Ministry, I am convinced that we could not do our work so well under any other department of Government, and I should be very sorry to have to return to a grant-in-aid.

G. C. SIMPSON.

Meteorological Office,
Air Ministry,
Adastral House, Kingsway,
London, W.C.2,
February 5.

High Energy γ-Ray from Thorium Disintegration Products.

IN the light of the standard measurements of the β-ray spectra of radium-B and -C by Ellis and Skinner (Roy. Soc. Proc., A, vol. 105, p. 60, 1924) it was thought advisable to remeasure the spectra of thorium-B, -C, and -D. This has been done, using the now well-known focussing method, and the results will be published in due course. The purpose of this letter is to direct attention to two lines of high energy, namely, 2·55 and 2·62 million volts, with a possible third of slightly greater energy. The detection of these lines has been made possible by the preparation of thorium-B sources of greater strength than usual. There is no doubt of their existence, as they appear very clearly and sharply on the photographic plate. What is most remarkable is the fact that these lines correspond to the conversion of a γ-ray of energy 2·64 million volts in the K and L levels of an atom of atomic number 82 or 83, despite the fact that their energy is some twenty-eight times as great as that of the K level of an atom of that atomic number. This shows that the quantum relations hold for these high energy values in exactly the same way as they have been shown to do for the lower ones. From an examination of the plates, it is seen that these lines lie beyond the region of the continuous background, and this fact may be of importance in atomic theories. Another point of interest is that there appear to be no lines between these and those of an energy of about 0·8 million volts. D. H. BLACK.

Cavendish Laboratory, Cambridge,
January 17.

Touch and Sight *v.* The Microscope in Wool Classing and Sorting.

NOT only do the fleeces from distinct breeds of sheep vary very considerably, but also, almost without exception, each individual fleece is made up of from three to seven or eight "qualities" of fibre.

To the non-technical reader the term "quality" is something of a mystery, so it will be well clearly to define this term before proceeding further. This term has no reference to the "fibre-stuff," but refers principally to the fibre diameter. Thus, if q = quality number and d = fibre diameter in the fraction of an

inch, the following equations link up "quality" and "fibre diameter":

$$\text{Log. } q = \frac{1}{1{\cdot}6}(\log 1{\cdot}52 + \log d), \quad . \quad . \quad (1)$$

or

$$d = \frac{1}{1{\cdot}52\ q^{1{\cdot}6}}. \quad . \quad . \quad . \quad . \quad (2)^1$$

Taking (1): with a 58's quality, the following result is obtained:

58's quality = 1/1000 in. diameter.

Taking (2): with a fibre of 1/1000 in. diameter the following result is obtained:

1/1000 = 58's quality.

In List I. the relationships between quality numbers 28's to 100's and fibre diameters are given.

LIST I. — RELATIONSHIPS BETWEEN BRADFORD QUALITY NUMBERS AND FIBRE DIAMETERS IN FRACTIONS OF AN INCH.

μ ($\frac{1}{1000}$ of m.m.).	Bradford Quality Number.	Diameter Reciprocal by Formula.
		in.
80·89	28's	314
65·30	32's	389
54·04	36's	470
42·69	40's	595
39·19	44's	648
36·50	46's	696
34·14	48's	744
31·95	50's	795
30·02	52's	846
28·25	54's	899
26·65	56's	953
25·23	58's	1007
23·86	60's	1064
21·52	64's	1180
19·54	68's	1299
18·66	70's	1361
15·06	80's	1686
12·48	90's	2034
10·54	100	2408

The connexion between the quality number and the fibre diameter is now quite evident; but the question at once arises as to what the quality number really represents.

The quality number represents the number of hanks of 560 yards each to which one pound of the particular wool in question may be spun. Thus, 58's quality conveys to the spinner the information that

58 × 560 = 32,480 yards

may be spun from one pound of this wool. Thus, in a sense, the quality number represents the fineness of yarn (thread) which may be spun from any wool under consideration. In actual practice it is agreed that, broadly speaking, the quality number is rather greater than the corresponding length of thread. Thus, a 58's quality wool would not, as a rule, be spun to a count finer than 50's, that is:

50 × 560 = 28,000 yards per lb.

Thousands of wool-classers[2] in Australia and elsewhere, and of sorters in Bradford and elsewhere, are daily classing or sorting fleeces of wool into the respective "qualities," and one or two interesting questions arise with reference to this work. In the first place, Is a sorter always consistent in his sorting? Does he always class the finer wool, say in a typical merino fleece, as 80's, the medium as 70's, and the coarse as 64's? And if he is found to be doing this according to the given equation to-day, did he make the same classification last year, and will he be making the same classification next year—say, as a test case, after six months away from the sorting table? More important still, will the wool-sorter in Bradford sort his fleeces into the same qualities that the Australian wool-classer would make, and will he be equally consistent in his sorting?

The writer has recently had the opportunity of carrying out certain classing and sorting tests in Australia, and later in Bradford, which, at least in part, answer these questions. On Bundure Sheep-station (New South Wales) the wool-classer was asked to select three typical qualities of wool, 68's, 64's, and 60's. Later, these were measured under the microscope, and upon these measurements the "frequency curves" shown in Fig. 1 were constructed and the "average diameters" of the three qualities of wools ascertained. It will be noted that the

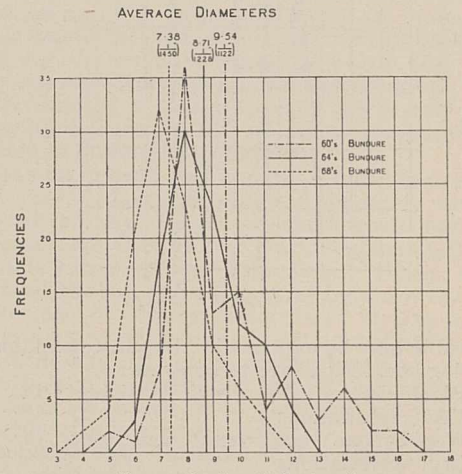

FIG. 1.—Bundure "Classings."

microscope almost exactly confirms the wool-classer's relative qualities, but that so far as coincidence with List I. is concerned, the Australian wool-classer is almost a quality lower than the list.

Later, Camden Park (Sydney) merinos were submitted to a wool-sorter in Bradford, and he made of these wools three qualities, 80's, 70's, and 64's. Again, on the sorting being tested by the microscope, it is found that the sorter is quite consistent with his own qualities, the frequency curves being given in Fig. 2. On comparing Figs. 1 and 2, however, it is found that, following the microscopic measurements, approximately the same fibre diameter (1/1400 in.) is stated as 68's by the Australian wool-classer and as 80's by the Bradford wool-sorter. On comparing the 64's, however, it will be noted that the Australian wool-classer's 64's (Fig. 1) has a fibre diameter of 1/1122 in., while the Bradford wool-sorter's 64's (Fig. 2) has a diameter of 1/1311 in., *i.e.* finer than the Bundure 64's (1/1228 in.). Both are finer than would be expected from List I., and no doubt indicate that just as the temperature of the hand before estimating the temperature of a liquor may affect the estimate, so may touch and sight testing be affected by the exercising of these faculties just previous to the quality estimates in question.

These differences may further be explained as follows: The Bradford sorter is possibly sorting his wools into rather higher qualities than those prevailing in pre-War times. Again, the amount of "yolk"

[1] See "Woollen and Worsted Spinning," Wilkinson's Rule, p. 231 (Messrs. Cassell and Co.).

[2] "Classing" is the term applied to the estimation of the "quality" of the whole fleece; "sorting" is the term applied to the separation of the several qualities in one fleece.

(grease, etc.) in the fibre varies with different wools, and in the case of these two wools was approximately :

Bundure : 50 per cent. loss on scouring ;
Camden Park : 60 per cent. loss on scouring.

Thus, as the micro-measurements were made after clearing with ether and the classing or sorting carried out "in the grease," certain of the differences

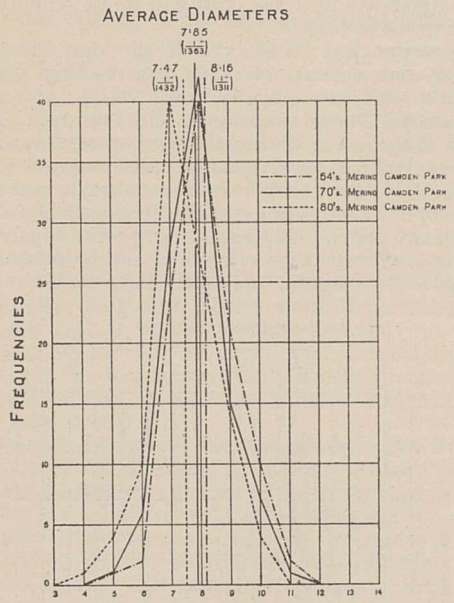

FIG. 2.—Bradford "Sortings."

observable may be explained. Broadly speaking, the following conclusions are to be drawn :

1. Wool-classers are very consistent in their "quality" estimations ;

2. Wool-sorters are very consistent in their "quality" estimations ;

3. Wool-classers as against wool-sorters and vice

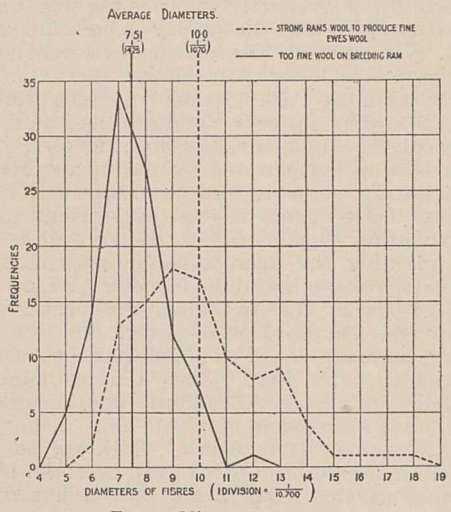

FIG. 3.—Micro-measurements.

versa are broadly consistent in their "quality" estimations ;

4. Wool-classers in Australia as against wool-sorters in Bradford show small differences in their "quality" estimations—not always unimportant—when contrasted with one another ;

5. Varying trade standards and varying conditions of the wools being classed or sorted affect the quality estimation ;

6. Micro-metrical measurements may almost always be made under similar conditions, so that such "quality" estimations should be quite consistent ;

7. Owing to the impossibility of examining more than a very few of the fibres under estimation (100 tests each in Figs. 1 and 2) the micro-metrical estimation is liable to give very erroneous results unless the test samples of fibres examined are very carefully selected and are truly representative of bulk.

It would thus appear that, under normal conditions, the work of the well-trained wool-classer or wool-sorter is trustworthy and that, broadly speaking, micro-metrical sorting will not be markedly better, and, if not carefully undertaken, may be worse.

An interesting case, however, arises when one wool happens to be, say, a 70's quality because the fibres are very consistently 1/1300 in. in diameter, and another wool is a 70's quality because many fibres above 1/1300 in. in diameter are balanced by others below even 1/1000 in. Such a case as this is partially in evidence in Fig. 3. Here are given the frequency curves for two wools specially selected by a noted Australian breeder as typical of a wool too fine (70's) and a wool about right (60's) for selected rams. The two curves reveal an astonishing difference in the "make-up" of the respective wool staples, of which the breeder was totally unconscious and which neither wool-classer nor wool-sorter would be likely to make note. It should also be noted that the narrow bases of the curves in Fig. 2 as against the broad base of at least one of the qualities in Fig. 1 might also tend to confuse the "classer" and the "sorter." Little has been done in such "correlating" as that treated here, but the subject is full of interest, and may prove to have most important bearings upon the selection of rams for breeding purposes both at home and in the Overseas Dominions. In the Textile Industries Department of the University of Leeds extensive ranges of typical Merino and British pedigree wools are being dealt with, and it is hoped that eventually (*a*) definite standards and (*b*) accepted methods of testing may be adopted throughout the wool industry both at home and abroad.

A. F. BARKER.

The University,
Leeds.

The Theory of Hearing.

IN NATURE, April 22, 1922 (vol. 109, p. 518), I pointed out that a series of clicks from a toothed wheel speeded up or down or by the voice is heard as a rising or falling tone and not as a noise or a jumble of tones. This fact contradicts the resonance theory of the mechanism of the cochlea.

The theory has now received a blow in the experiments of Dr. Harvey Fletcher at the Research Laboratories of the American Telephone and Telegraph Company and the Western Electric Company in New York (*Phys. Rev.*, 1924, xxiii., No. 3). The fundamental and a large number of harmonics can be eliminated from a compound tone without changing the pitch of the tone. A high-quality telephone system was used about which it was known that the sound coming out of the receiver was a faithful copy of that going into the transmitter. Electrical filters were introduced so that any tones could be eliminated. The character of the results was judged by three persons familiar with music, who agreed in every case. Typical experiments are the following :

Sound.	Pitch.	Eliminated components.	Eliminated frequencies.	Pitch change.	Quality change.
Voice *ah*	145	F	0 to 250	None	Inappreciable.
		F+1 to 2	0 to 500	,,	Small.
		F+1 to 4	0 to 750	,,	Large.
		F+1 to 7	0 to 1250	,,	Very large.
		F+1 to 9	0 to 1500	Uncertain	Noise.
		6 to ∞	1000 to ∞	None	Small.
		3 to ∞	500 to ∞	,,	Large.
		F −1 to 2 −6 to ∞	0 to 500 +1000 to ∞	,,	Very large.
Clarinet	259	F	0 to 500	,,	Large.
		F+1 to 2	0 to 1000	,,	Very large.
		F+1 to 4	0 to 1500	,,	Non-musical.
		7 to ∞	2000 to ∞	,,	Large.
		2 to ∞	750 to ∞	,,	Pure tone with no clarinet quality.

The work of Wegel and Lane (*Phys. Rev.*, 1924, xxiii., No. 2) and Fletcher (*Phys. Rev.*, 1920, xv. 513) has shown that the hearing mechanism displays a non-linear response to external forces. The character of the sensation when two tones are acting together on the ear varies considerably with the relative frequency and intensity values (Wegel and Lane). According to their dynamical theory, the vibrations pass along the basilar membrane and are shunted through narrow regions of the membrane at points depending on the frequency. The dynamic theory is simply a modified resonance theory.

Any resonance theory fails to explain Fletcher's experiments. When, for example, the fundamental is removed from a clarinet tone, there is no change in the pitch of the tone. According to the resonance theory a sensation of tone corresponds to the vibration of a region of the fibres of the basilar membrane and vice versa. Here vast regions of the fibres may or may not vibrate without altering the sensation of pitch. The only change is one of quality. Fletcher attempts to get around the difficulty by supposing that subjective tones—summation and difference tones—are introduced (!) mechanically in the cochlea into the stimulus that is sent to the brain. For example, the presence of the tones 500 to ∞ in the clarinet experiment produces a sensation of a tone of the same fundamental pitch as 259 to ∞ with only a difference in quality, because these tones arouse the missing tones in the cochlea.

This is a responsibility too heavy to be accepted on the basis of a hypothetical resonance analysis of the basilar membrane. The responsibility becomes much less when the fibres of the membrane are regarded only as supporting and stiffening fibres not tuned to resonate. The result then becomes identical with my deformation theory reported in NATURE, April 26, 1924 (vol. 113, p. 605). According to this theory, the basilar membrane alters the linear movement of the stapes into a change of form in three dimensions. Every external vibration produces a pattern deformation of the membrane. This pattern is communicated to the brain. A single vibration of a clarinet tone produces a definite pattern in three directions on the basilar membrane. The mental quality of the clarinet tone represents this pattern. When this vibration is repeated regularly, the clarinet quality appears to be based on a tone of definite pitch. Whether a tone of this pitch or of any other pitch is physically present in external vibrations or not, a fundamental will be heard as the loudest tone, the pitch of which is determined by the frequency of the repetitions.

Fletcher's experiments are an illustration of what occurs constantly in song. Many, perhaps most, vowels have no fundamental vibrations (NATURE, Jan. 13 and 20, 1921, pp. 632 and 664). They are produced by a series of isolated puffs which set the vocal cavities in vibration. Such vowels consist solely of higher tones than the one that is sung. Yet, although the fundamental is lacking physically, it is heard as *the* tone of the voice. The physically non-existent tone is exactly the one—and the only one—indicated by the music. It is the tone intended to be sung, and is the one heard as a tone; the other tones—in this case all the tones that exist physically—are heard only as timbre or quality.

The work of Willis, Hermann, and myself on the vowels is now supplemented by the work at the New York laboratory. All of it flatly contradicts the resonance theory. The simple facts of the accelerated toothed wheel and of portamento speech, however, ought to have been enough to convince any one.

E. W. SCRIPTURE.

University of Vienna.

The Ages and Masses of the Stars.

THE very interesting correspondence between Mr. Schumann and Dr. Jeans in NATURE of January 24 has not touched on one of the most difficult questions, raised by the brilliant paper in which Dr. Jeans makes out such a strong case for extending our time-scale for the life of a star to some 10^{13} to 10^{14} years. The problem is simply how we are to account for the existence of uranium and thorium.

As is well known, uranium has a half-life period of 6×10^9 years. Therefore, even if the whole sun had consisted initially of uranium, there would barely be 2 kilograms left after 6×10^{11} years. A great deal more than this exists on the earth alone. Hence, either the life of the sun and earth must be much less than 6×10^{11} years or we must make the *ad hoc* assumption that uranium is being formed or at any rate prevented from disintegrating. The temperature and pressure inside the sun are much too low to affect a reaction, the energy of which is so great as the energy of formation of radioactive substances.

A solution may be found if one admits the coalescence and annihilation of protons and electrons, for then, of course, radiation with quanta of energy $1{\cdot}66 \times 10^{-3}$ would be available. That this might photosynthesise uranium nuclei, though of course possible from purely energy considerations, scarcely seems plausible when one remembers that these complicated structures contain 238 protons and 146 electrons. But it is not impossible that it might cause α-particles, which are presumably common in the interior of stars, to combine with lead and the heavier radioactive elements. On such a theory presumably the non-radioactive substances would be assumed to be built up in the same way.

The basis of this explanation, however, the seductive hypothesis that protons and electrons may coalesce and be annihilated, is not without difficulties of its own. The process in question presumably would occur when a proton and electron meet under certain peculiar conditions. The frequency of such encounters must almost certainly depend upon the density and, to a less extent, on the temperature. The position would be much clarified if it could be shown from astronomical evidence that the evolution of energy per unit mass varied in the appropriate way with the density and temperature.

These or similar speculations, which become inevitable if one accepts the extended time-scale, had therefore perhaps best be postponed until Dr. Jeans's theory has been further tested. They would be avoided, of course, if it could be shown that the loss of ordinary atomic mass under the influence of radiation pressure is much greater than the radiative mass emitted. It is difficult to make any convincing

estimate, but should it prove to be so it would immediately reduce our time-scale and relieve us of the necessity of entering upon speculations such as those touched on above.

F. A. LINDEMANN.

Clarendon Laboratory,
University Museum, Oxford,
January 30.

On the Hardness of Manganese Steel.

NOTWITHSTANDING its extraordinary importance, the discovery of the 13 per cent. manganese steel, made by Sir Robert Hadfield more than forty years ago, has scarcely been elucidated regarding its most striking point, namely, the extremely high resistance to wear and tear, or the fact that the non-magnetic manganese steel, while comparatively soft in itself, offers an enormous resistance to a working tool.

It is natural to assume that this resistance is to be explained in the following way: [1] The state of the iron in the manganese steel being that of the non-ferromagnetic γ-iron, stable at high temperature but unstable at ordinary temperatures, a mechanical stress is likely to cause the transformation into the ferromagnetic α-state, stable at low temperature. This is in conformity with a general law of physical chemistry, exemplified by the well-known case of mercury iodide: the yellow modification, persisting at ordinary temperature in an unstable condition, is transformed by mechanical stress into the red modification, stable at low temperature. In other words: the high resistance is explained by the assumption that mechanical work transforms the relatively soft Mn- austenite (γ-Fe) into martensite (α-Fe), known to be extremely hard. From this view, if correct, it follows that mechanical work will at least partly transform the non-magnetic manganese steel into the ferromagnetic α-condition.

Some time ago the correctness of this conclusion was tested at this Institute by Dr. A. Westgren on a specimen, sent by Sir Robert Hadfield, of manganese steel which had been subjected to a tensile test.

On X-ray analysis, however, no lines characteristic for α-Fe could be detected even in the contracted part of the specimen. In view of this negative result, the following experiment, lately performed, seems to be of interest.

A small steel magnet needle (about $3 \times 0{\cdot}5 \times 0{\cdot}1$ mm.) was fastened to one end of a thin silica fibre, so as to be suspended in a vertical position. On approaching the sharp corner, or edge, of a Hadfield manganese (Era) steel specimen, it was not possible to obtain any sensible attraction of the needle—in conformity with its non-ferromagnetic character. On the other hand, a small drilling of the same steel (say $1{\cdot}2 \times 0{\cdot}4 \times 0{\cdot}1$ mm.) fixed at the end of a glass capillary, when brought near the needle, revealed a considerable attraction, or repulsion, proving the *drilling to be plainly ferromagnetic*, and this even permanently. The objection being possible that the ferromagnetism might be caused by steel particles given off by the drill used, metallic shavings were obtained by using sharp quartz edges, and also a slow rotating alundum disc; in both cases the shavings were found to be distinctly ferromagnetic.

Since it had been established in this way that the shavings have the magnetic characteristics of martensite, they were submitted to X-ray analysis by Dr. Westgren. However, no lines of the α-state could be detected. The reason probably lies in the fact that the α-lines are sharp only for a comparatively pure α-iron lattice, and rather blurred for the α-solid solutions; if in addition the α-portions occurring are few in number and very small, the analysis method developed as yet, is not sensitive enough to detect them. It may be considered as established that the difficulty in working non-magnetic manganese steel, is due, at least partly, to its partial transformation into martensite.

CARL BENEDICKS.
(Director.)

Metallographic Institute, Stockholm.

[1] C. Benedicks, "Hadfield's undersökningar över specialstål," *Teknisk Tidskrift*, Bergsvet, 1923, p. 25.

A Stroboscopic Method of Determining Surface Tension of Liquids.

OF the various methods of determining surface tension of liquids, the method of ripples is free from all surface influences. Lord Rayleigh, Dorsey, Grünmach, Kalähne and others have determined the surface tension of water by this method. Grünmach applied the same method in determining the surface tension of some of the molten metals; but the main difficulty was that of observing the ripples properly to measure the wave lengths exactly, and the accurate estimation of the vibration frequency of the exciting fork. Unless the stroboscopic arrangement is perfect, there is always an uncertainty in the determination

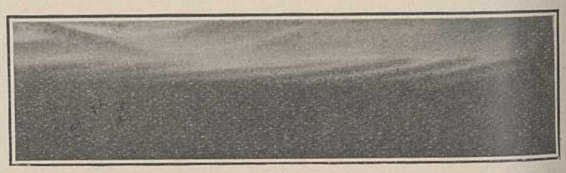

FIG. 1.

of λ accurately, and as λ^3 is to be taken in the calculation, a slight variation in the value of λ affects the final value.

We have, however, devised a method by which the stroboscopic arrangement is completely satisfactory. By fixing a fine edge to the prong of the exciting fork, and observing the reflection of this edge on the surface of the liquid at Brewster's angle (for water it is 53° 6′) fine teeth appear on the reflected image of the fine edge. These teeth remain absolutely stationary so long as the vibrations of the fork remain constant. The tips of the teeth are extremely sharp and stand a good deal of magnification (Fig. 1). The measurements of λ, therefore, could be made accurately. The excitation is produced by a fine needle soldered to one end of this edge, the needle dipping only about 0·25 mm. below the liquid surface. The ripples are scarcely visible on the surface.

The result given by this simple apparatus is satisfactory, namely, 74·1 in the case of clean distilled water. The vibrations of the tuning-fork are also recorded along with a standardised seconds pendulum, so that the frequency can be ascertained with great accuracy up to the second place of decimals. A slight touch of grease at once increases λ considerably, as has been pointed out by Lord Rayleigh.

P. N. GHOSH.
D. BANERJI.

University College of Science,
Calcutta,
December 24.

The Permanence of Substance.

By Sir JOSEPH LARMOR, F.R.S.

IN Victorian times the atoms of matter were described by Clerk Maxwell, in picturesque and weighty phrase, as the "foundation stones of the material universe." It was believed that an æthereal medium for physical intercommunication in the cosmos was essential: and if so, material systems could not arise as other than mobile structures inhering in that universal medium. The standard illustration (for that was its true function) which went far by visual experiment to give vitality as well as precision to this general doctrine, was the Kelvin formulation of vortex atoms, based on Helmholtz's advances in the exact hydrodynamics of ideal perfect fluid, and lying in the natural succession to the brilliant but often fantastic gropings after vortical imagery by Descartes. The force of the illustration lay in the certainty that in the ideal pervading medium such vortex structures could not be wiped out, must be indestructible for ever. The ultimate atoms of matter, which stimulated the investigation of these vortical ring structures by way of analogy, have now been pushed back, first in theory and afterwards far more precisely by experimental discovery, to the electronic constituents of the chemical atoms.

If there is an æther, matter must be of necessity atomic, the possible variety of atoms being restricted to the limited number of types of suitable structure that are dynamically stable: and conversely, if matter is found to consist actually of self-contained atomic structures, this central fact is either evidence for a universal æther in which all matter subsists, or else must remain wholly inexplicable, perhaps even inscrutable. Such would be the modern version of the great argument of Democritus, on atoms and the void.

On the other hand, in extreme modern developments of the idea of relativity, the material universe seems to have no "foundation stones." An ultimate atom of matter is not there describable as an essential structure at all, such as can be explored, of course only partially, yet to an increasing degree which becomes adequate for more and more scientific purposes. It usually appears as nothing but a local aggregation of electric charge, held together by unknown internal constraint which is assumed not to disturb other relations. It can thus be liable to dissolve itself into pure motional energy by fusion with opposite charges; and the fact that the measures of mass and energy are modified in the same way by change of the frame of reference lends plausibility. The end of the cosmos would be the vanishing of matter: its beginnings must be on every scheme inscrutable.

It seems to be mainly with a view to elegance and completeness in the algebra that the electronic nucleus is thus introduced merely as a local aggregation of electric charge with some permanent law of volume-density. At a later stage it became recognised that internal forces are needed to hold it together; and whatever they may be they must not interfere with its necessary relativity as a whole as regards uniform translatory motion. They seem to be disposed of by being classed in the exposition as an unknown part of the stress-tensor of the field. Thus this procedure can be in no respect an improvement on the classical method which it claims to supersede, of regarding an electron as a structural singularity unknown except so far as it is defined by increasing knowledge of the field that is physically attached to it by its very constitution. Even in pure spatial analysis of differential geometry a singular pole is approached through the influence it sheds around: the algebra never gets into the inside of it, so to say. That is the classical way, and can be held to be the correct scientific method, of approach to the properties of the unknown permanent electron or atom. The occasional denial of it seems possibly to be linked up with a metaphysical doctrine[1] that all natural law is nothing more than a manifestation of the *quasi*-geometric qualities of a fourway continuum named space-time; so that a complete exploration throughout it, by continuous spatial analysis without inherent unexplored poles, must be the aim of physical theory. The alternative view is that the infinitely little transcends human grasp by involving just as great inherent complexity as does the infinitely large; though both can be approached and annexed, with increasing completeness, to our scientific schemes, by virtue of transcendental relations of mind to matter which lie at the root of all possibility of knowledge or scientific formulations.

In further illustration of the contrast of methods, these hypothetical internal stress-forms the rôle of which is to hold a local distribution of electric density together, and so constitute an electron, may be more closely considered. They are now often referred to as the "forces of Poincaré," because he found out that for a shell model of the electron they can be formulated simply as an isotropic pressure, and without doing any violence to the relativity postulate for the structure. But, on the illustrative analogy of a rotational æther, it had been familiar that, for any static model, all that was required was to bring into play in the theory just this hydrostatic pressure that obviously can subsist in such an æther. Yet, viewed from this more concrete or physical point of view, that was not sufficient; for it was immediately recognisable that such a shell model is an unstable structure, much as is actually an electrified soap-bubble, thus requiring that analogies along that line had to remain in abeyance pending possible formulation of plausible slight constraints such as might protect the illustrative structure from destruction. But without assuming any definite internal structure for the electron at all—all such models are suggestive and valuable for consolidation of knowledge, none can be complete or final—we can postulate merely that it is permanent and is mobile, and explore, by mixed observation and theory, the nature of the field around it with continually increasing precision, and also the mutual influences of neighbouring electrons which arise from the superposition of their fields. This tentative procedure runs parallel to the course of actual progress: while any postulate of reduction of physical science to a self-contained

[1] An alternative form of the postulate, that nothing may be the subject of reasoning that cannot be observed, seems to imply a sense of humour.

geometric analysis in space-time may savour of reproducing the infinite with finite appliances.

It was already implicit in the Maxwellian æther-theory of half a century ago that a loss of energy δE from a material system, if it occurs by radiation, involves proportionate loss of inertial mass, of amount $\delta E/c^2$, where c is the speed of radiation: and vice versa. Such loss would have to fall on the internal relative potential and kinetic energies of the constituents of the radiating atom. There appears to be some astronomical knowledge now available, following on the lines of an idea recently introduced and explored by Dr. Jeans (Monthly Notices R.A.S., November 1924, just now to hand), to estimate extreme superior limits restricting the amount and duration of radiation from the sun or a star that could be conceivable from this source of supply. This new type of limit, doubtless, however, quite unapproachable, and uncertain as depending on an estimate of the internal mutual energies of the atom that may be available for running away into radiation, would stand in contrast, for example, with the famous historical estimate, enormously smaller, afforded by the running down into radiation of energy located outside the atoms, that of the mutual gravitation of the parts of the system in bulk; which was put forward in the early days of the conservation of energy by Kelvin and independently in more searching and complete manner by Helmholtz to explain the solar heat, but is now regarded on cogent grounds as inadequate for the facts of cosmic evolution when taken by itself.

Data are perhaps not entirely wanting for an estimate of the kind here described, along two ways of approach. The total energy of relative positions and motions of electrons and other ultimate nuclei in the atom, such as might by the hypothesis possibly escape into energy of radiation, can on the lines of present general ideas of atomic structure be roughly set out. Indeed, the maximum possible transfer into radiant energy for all time would be measured by the total mutual energy of the initially disgregated elements, electrons and nuclei, that first fall into chemical atoms, of orbital type, and then ultimately on their destruction lapse together into closest contact. It is conceded that if atomic nuclei are regarded as finite electric charges concentrated almost into mere points, thus involving practically infinite space-density and so allowing the charges to approach infinitely near, this amount of possible radiation could tend to increase beyond measure. But that would introduce infinities in all directions, for example, infinite inertia of an atom, and is perhaps not contemplated on any kind of theory. (As the complete transformation, vice versa, of the gases from 1 c.c. of radium releases heat to the order of 10^7 calories, an easy computation shows that the preponderant nuclear energies of the atoms must there be very deeply drawn upon, as, of course, is now familiar, though not so much as to involve recognisable diminution of mass. Cf. Rutherford and his coadjutors, as reported in his treatise.)

There seems to be another corroborating mode of approach, which must indeed be obvious; one which also affords some confirmation of our postulate of indestructibility of the primordial atoms. It lies in the cardinal discovery of Aston that the standard relative atomic masses of all the chemical elements are expressible in high approximation by integers, with only one challenging exception. When in the cosmic process two atoms are imagined to combine, forming an atom of a more complex kind of matter, there would thus be no room for much conversion of mass into energy: the mutual energy, residing in the local fields, that can become free to run away into radiation, must correspond to the equivalent of a very small portion, perhaps on the experimental results not more than one-tenth per cent., of the total mass, however intimate be the consolidation that is required into one central nucleus for the new atom.

For astronomical purposes Dr. Jeans has made an estimate of the course of evolution for the universe, if all the matter in it were classed as a form of energy convertible into radiation. He finds, on Eddington's hypotheses, that durations of the present cosmic order ranging around two hundred millions of millions of years would become conceivable. Perhaps if only the mutual positional and motional energies of the ultimate discrete constituents of atoms could at the very most run into radiation, the energy thus assumed to be available (which is no measure of the duration of the system) must be reduced on the first estimate above by a factor which might be as small as 10^{-8} or as great as 10^{-5}, and on the other by a factor which could not exceed 10^{-3}.

Apart from such interesting change in formulation of an ultimate cosmic problem, the object of the present discussion is to concentrate on one fundamental question, which has become conspicuous in much recent ultra-physical speculation. Is matter to be regarded as consisting irrevocably of primordial atomic structures absolutely permanent: or alternatively, discarding all structural analogies based on classical dynamical principles, are the atoms, if such then really are retained, to be considered as mere concretions or aggregations liable to dissipate entirely into energy of radiation and so vanish?

Biographical Byways.[1]

By Sir ARTHUR SCHUSTER, F.R.S.

7. OSBORNE REYNOLDS (1842–1912).

WHENEVER I hear of a man who is described as being lovable, the figure of Osborne Reynolds rises up before me; and yet I doubt whether on a casual acquaintance or in official intercourse that adjective would have suggested itself. In ordinary conversation he often took a cynical view of things; he was obstinate in adhering to his own opinion, absolutely uncompromising, and sometimes a little hasty in imputing selfish motives to his opponents. But the discordant elements of his character were fused together by an almost primitive simplicity of mind, and after closer acquaintance few could resist the charm of his strong personality.

His loyalty to friends and colleagues knew no bounds.

[1] Continued from p. 199.

In 1883, Mr. E. J. Stone, formerly Astronomer Royal at the Cape of Good Hope and—at the time—president of the Royal Astronomical Society, made a series of communications to the Society in which he claimed to show that the discrepancies between the lunar tables and the observed position of the moon had no reality, but were only natural consequences of the changes which had, from time to time, been introduced in the adopted mean solar day; and in particular, that the errors of Hansen's tables of the moon were due to the adoption of Leverrier's solar tables by the British Nautical Almanac. The matter was of the highest importance, as it affected our fundamental unit of time. The subject is intricate and full of pitfalls, but clear-headed men like Adams, Cayley, and Newcomb all came to the conclusion that Stone's assertion could not be maintained. I must have mentioned the matter to Osborne Reynolds. He had no special interest in astronomy; in fact, he knew very little about it, but he had been a fellow of Queen's College, Cambridge. So had Stone, and that was sufficient reason why Stone should be right. When I quoted Cayley and Adams it made no impression. Reynolds maintained the general thesis that when a man of established reputation has the whole scientific world against him, it is quite certain that the man who stands alone is right. After considering the subject for a few days he came to me and said: "I have gone into the question, and I remain convinced that Stone is right." Again two days later he expressed the same opinion. Another week passed and he recanted, admitting that Stone was wrong. But he had spent more than a week on a new, and probably uncongenial, subject in the forlorn hope of being able to support a friend.

An interesting chapter in the history of science could be written on the hampering effect of knowledge that is either deficient or too complete. Ignorance may lead astray, but perfect knowledge often acts as a brake and stops the car when a reckless spurt would take the driver into new territory. For the moment I am thinking of the early history of the radiometer, though this is not perhaps the best example that could be chosen. The manner in which Crookes was led from certain irregularities of weighing to the construction of his interesting little instrument was wholly admirable, and some of the steps in the research, such as the improvement of air-pumps, marked considerable advances, while other incidental results are of permanent value. But it is permissible to ask whether any one wholly conversant with the property of gases at low pressures, and therefore able to anticipate the effect discovered by Crookes, would have taken all the trouble to spend two years in demonstrating it. Even if familiar with Maxwell's radiation pressure, perfect knowledge would have recognised that there was no immediate hope of verifying it experimentally until the methods of obtaining high vacua were improved to a degree not dreamt of in those days.

There can be no doubt that the driving power of Crookes's work was the hope of discovering a new property of radiation. The first communication read before the Royal Society in December 1873 concludes with the following statement: "In the radiant molecular energy of cosmical masses may at last be found that 'agent acting constantly according to certain laws,' which Newton held to be the cause of gravity." He modified his views later, and ascribed the effect to light "even where there is no heat" (NATURE, Vol. 12, p. 124).

Reynolds recognised that the apparent repulsion could be explained without the help of unknown forces in the belief, at first, that they were due to condensed moisture evaporating under the influence of thermal radiation; but he soon replaced this view by the now generally accepted theory. Johnstone Stoney had put forward similar ideas which, nevertheless, differed in essential points.

During the winter of 1873–74 I suggested to Reynolds, as I had done to others, that the main question whether the repulsion was caused by internal or external forces could be solved in a very simple manner, by the reaction on the containing vessel. When I returned in November 1875 from the Siamese eclipse, I found controversies still raging, but no one had taken the trouble to try the crucial experiment. I was reluctant to do so myself, as a number of persons were working on the subject, and I have perhaps an exaggerated objection to cutting into what I consider to be other people's work. I repeatedly spoke to Reynolds about it in the hope that he would take the matter up. One evening after lecturing hours, while I was working alone in the Physical Laboratory, Osborne Reynolds entered the room and said: "I want you to do that experiment you spoke of, and to do it now. I have got everything ready for you." I went with him to the lecture room. We suspended the radiometer with an attached mirror, and, at the first trial, it behaved as it should. The vessel swung round as soon as the light fell on the blackened surfaces, and returned to its position of rest when the rotation of the vanes had reached the steady state. Reynolds would not listen to the proposal of a joint communication, and my paper appeared in due course in the Philosophical Transactions.

In his writings, as in his speech, Reynolds was difficult to understand. His brain seemed to work along lines different from those of the majority of us. He looked upon all things in an original manner, and the education of his children was one of them. I once found him playing with his little son, and nothing seemed to give him greater pleasure than when the boy did the opposite thing to that which he was asked to do. "Come here," said Reynolds, and when the child went further away Reynolds was delighted, interpreting the act as showing independence of spirit. The incident made a great impression on me.

In his later years Reynolds had difficulty in finding the right word, using sometimes one that had the opposite meaning to that required. This failing ultimately developed into a regular aphasia.

The value of his scientific work is admirably described in the obituary notice published by the Royal Society. It may be added that though his theory of the construction of the universe, on which he concentrated his whole strength at the end of his scientific life, received little support, it may yet find its place in reconciling the old and new physics.

In his lectures Reynolds was often carried away by his subject and got into difficulties. Some humorous incidents are related with regard to the manner in which he got out of them. He was once explaining the slide

rule to his class; holding one in his hand, he expounded in detail the steps necessary to perform a multiplication. "We take as a simple example three times four," he said, and after appropriate explanations he continued, "Now we arrive at the result; three times four is 11·8." The class smiled. "That is near enough for our purpose," said Reynolds. It may be imagined that the average student was often puzzled; but nevertheless, the number of scientific engineers of high standing that he trained is a testimony to his teaching power, when he had the right material with which to deal. That power was not one of imparting knowledge but rather of stimulating thought.

Not long ago a representative of the University of Manchester lectured in the United States. At the conclusion of the lecture a gentleman stepped out from the audience, and addressing the lecturer, said: "I understand that you come from Manchester. I owe all my success in life to Osborne Reynolds, and I ask you to accept a cheque for the benefit of the University as a sign of gratitude." No one could wish for a higher testimonial than that.

The Fossil Anthropoid Ape from Taungs.

By Sir ARTHUR KEITH, F.R.S.

THE discovery of fossil remains of a "man ape" in South Africa raises many points of great interest for those who are studying the evolution of man and of man-like apes. No doubt when Prof. Dart publishes his full monograph of his discovery, he will settle many points which are now left open, but from the facts he has given us, and particularly from the accurate drawing of the endocranial cast and skull in profile, it is even now possible for an onlooker to assess the importance of his discovery. I found it easy to enlarge the profile drawing just mentioned to natural size and to compare it with corresponding drawings of the skulls of children and of young apes. When this is done, the peculiarities of Australopithecus become very manifest.

Prof. Dart regrets he has not access to literature which gives the data for gauging the age of young anthropoids. In the specimen he has discovered and described, the first permanent molar teeth are coming into use. Data which I collected 25 years ago show that these teeth reach this stage near the end of the 4th year, two years earlier than is the rule in man and two years later than is the rule in the higher monkeys. In evolution towards a human form there is a tendency to prolong the periods of growth. Man and the gorilla have approximately the same size of brain at birth; the rapid growth of man's brain continues to the end of the 4th year; in the gorilla rapid growth ceases soon after birth.

Prof. Dart recognises the many points of similarity which link Australopithecus to the great anthropoid apes—particularly to the chimpanzee and gorilla. Those who are familiar with the facial characters of the immature gorilla and of the chimpanzee will recognise a blend of the two in the face of Australopithecus, and yet in certain points it differs from both, particularly in the small size of its jaws.

In size of brain this new form is not human but anthropoid. In the 4th year a child has reached 81 per cent. of the total size of its brain; at the same period a young gorilla has obtained 85 per cent. of its full size, a chimpanzee 87 per cent. From Prof. Dart's accurate diagrams one estimates the brain length to have been 118 mm.—a dimension common in the brains of adult and also juvenile gorillas. The height of the brain above the ear-holes also corresponds in both Australopithecus and the gorilla—about 70 mm. But in width, as Prof. Dart has noted, the gorilla greatly exceeds the new anthropoid; in the gorilla the width of brain is usually about 100 mm.; in Australopithecus the width is estimated at 84 mm. The average volume of the interior of gorillas' skulls (males and females) is 470 c.c., but occasional individuals run up to 620 c.c. One may safely infer that the volume of the brain in the juvenile Australopithecus described by Prof. Dart must be less than 450 c.c., and if we allow a 15 per cent. increase for the remaining stages of growth, the size of the adult brain will not exceed 520 c.c. At the utmost the volume of brain in this new anthropoid falls short of the gorilla maximum. Even if it be admitted, however, that Australopithecus is an anthropoid ape, it is a very remarkable one. It is a true long-headed or dolichocephalic anthropoid—the first so far known. In all living anthropoids the width of the brain is 82 per cent. or more of its length; they are round-brained or brachycephalic; but in Australopithecus the width is only 71 per cent. of the length. Here, then, we find amongst anthropoid apes, as among human races, a tendency to roundness of brain in some and to length in others. On this remarkable quality of Australopithecus Prof. Dart has laid due emphasis.

This side-to-side compression of the head taken in conjunction with the small size of jaws throw a side light on the essential features of Australopithecus. The jaws are considerably smaller than those of a chimpanzee of a corresponding age, and much smaller than those of a young gorilla. There is a tendency to preserve infantile characters, a tendency which has had much to do with the shaping of man from an anthropoid stage. The relatively high vault of the skull of Australopithecus and its narrow base may also be interpreted as infantile characters. It is not clearly enough recognised that the anthropoid and human skulls undergo remarkable growth changes leading to a great widening of the base and a lowering or flattening of the roof of the skull. In Australopithecus there is a tendency to preserve the fœtal form.

When Prof. Dart produces his evidence in full he may convert those who, like myself, doubt the advisability of creating a new family for the reception of this new form. It may be that Australopithecus does turn out to be "intermediate between living anthropoids and man," but on the evidence now produced one is inclined to place Australopithecus in the same group or sub-family as the chimpanzee and gorilla. It is an allied genus. It seems to be near akin to both, differing from them in shape of head and brain and in a tendency to the retention of infantile characters. The geological evidence will help to settle its relation-

ships. One must suppose we are dealing with fossil remains which have become embedded in the stalagmite of a filled-up cave or fissure of the limestone cliff.

May I, in conclusion, thank Prof. Dart for his full and clear description, and particularly for his accurate drawings. One wishes that discoverers of such precious relics would follow his example, and, in place of reproducing crude tracings and photographs, give the same kind of drawings as an engineer or an architect prepares when describing a new engine or a new building.

By Prof. G. ELLIOT SMITH, F.R.S.

IT is a great tribute to Prof. Dart's energy and insight to have discovered the only fossilised anthropoid ape so far obtained from Africa, excepting only the jaw of the diminutive Oligocene Propliopithecus from the Egyptian Fayum. Whether or not the interpretation of the wider significance he has claimed for the fossil should be corroborated in the light of further information and investigation, the fact remains that his discovery is of peculiar interest and importance.

The simian infant discovered by him is an unmistakable anthropoid ape that seems to be much on the same grade of development as the gorilla and the chimpanzee without being identical with either. So far Prof. Dart does not seem to have "developed" the specimen far enough to expose the crowns of the teeth and so obtain the kind of evidence which in the past has provided most of our information for the identification of the extinct anthropoids. Until this has been done and critical comparisons have been made with the remains of Dryopithecus and Sivapithecus, the two extinct anthropoids that approach nearest to the line of man's ancestry, it would be rash to push the claim in support of the South African anthropoid's nearer kinship with man. Prof. Dart is probably justified in creating a new species and even a new genus for his interesting fossil: for if such wide divergences between the newly discovered anthropoid and the living African anthropoids are recognisable in an infant, probably not more than four years of age, the differences in the adults would surely be of a magnitude to warrant the institution of a generic distinction.

Many of the features cited by Prof. Dart as evidence of human affinities, especially the features of the jaw and teeth mentioned by him, are not unknown in the young of the giant anthropoids and even in the adult gibbon.

The most interesting, and perhaps significant, distinctive features are presented by the natural endocranial cast. They may possibly justify the claim that Australopithecus has really advanced a stage further in the direction of the human status than any other ape. But until Prof. Dart provides us with fuller information and full-size photographs revealing the details of the object, one is not justified in drawing any final conclusions as to the significance of the evidence.

The size of the brain affords very definite evidence that the fossil is an anthropoid on much the same plane as the gorilla and the chimpanzee. But while its brain is not so large as the big gorilla-cast used for comparison by Prof. Dart, it is obvious that it is bigger than a chimpanzee's brain and probably well above the average for the gorilla. But the fossil is an imperfectly developed child, whose brain would probably have increased in volume to the extent of a fifth had it attained the adult status. Hence it is probable the brain would have exceeded in bulk the biggest recorded cranial capacity for an anthropoid ape, about 650 c.c. As the most ancient and primitive human brain case, that of Pithecanthropus, is at least 900 c.c. in capacity, one might regard even a small advance on 650 c.c. as a definite approach to the human status. The most suggestive feature (in Prof. Dart's Fig. 5, p. 197) is the position of the sulcus lunatus and the extent of the parietal expansion that has pushed asunder the lunate and parallel sulci—a very characteristic human feature.

When fuller information regarding the brain is forthcoming—and no one is more competent than Prof. Dart to observe the evidence and interpret it—I for one shall be quite prepared to admit that an ape has been found the brain of which points the way to the emergence of the distinctive brain and mind of mankind. Africa will then have purveyed one more surprise—but only a real surprise to those who do not know their Charles Darwin. But what above all we want Prof. Dart to tell us is the geological evidence of age, the exact conditions under which the fossil was found, and the exact form of the teeth.

By Sir ARTHUR SMITH WOODWARD, F.R.S.

THE new fossil from Taungs is of special interest as being the first-discovered skull of an extinct anthropoid ape, and Prof. Dart is to be congratulated on his lucid and suggestive preliminary description of the specimen. As usual, however, there are serious defects in the material for discussion, and before the published first impressions can be confirmed, more examples of the same skull are needed.

First, as Prof. Dart remarks, the fossil belongs to an immature individual with the milk-dentition, and, so far as can be judged from the photograph, I see nothing in the orbits, nasal bones, and canine teeth definitely nearer to the human condition than the corresponding parts of the skull of a modern young chimpanzee. The face seems to be relatively short, but the lower jaw of the Miocene Dryopithecus has already shown that this must have been one of the characters of the ancestral apes. The symphysis of the lower jaw may owe its shape and the absence of the "simian shelf" merely to immaturity; but it may be noted that a nearly similar symphysis has been described in an adult Dryopithecus, of which it may also be said that "the anterior symphyseal surface is scarcely less vertical than that of Heidelberg man" (see diagrams in Quart. Journ. Geol. Soc., vol. 70, 1914, pp. 317, 319).

Secondly, the Taungs skull lacks the bones of the brain-case, so that the amount and direction of distortion of the specimen cannot be determined. I should therefore hesitate to attach much importance to rounding or flattening of any part of the brain-cast, and would even doubt whether the relative dimensions of the cast of the cerebellum can be relied on. Confirmatory evidence is needed of the reality of appearances in such a fossil.

In the absence of knowledge of the skulls of the fossil anthropoid apes represented by teeth and fragmentary jaws in the Tertiary formations of India, it is premature to express any opinion as to whether the direct

ancestors of man are to be sought in Asia or in Africa. The new fossil from South Africa certainly has little bearing on the question.

Palæontologists will await with interest Prof. Dart's detailed account of the new anthropoid, but cannot fail to regret that he has chosen for it so barbarous (Latin-Greek) a name as Australopithecus.

By Dr. W. L. H. DUCKWORTH.

PROF. DART'S description of the fossil skull found at Taungs in Bechuanaland shows that this specimen possesses exceptional interest and importance. Should the claims made on its behalf prove good, then its discovery will in effect be comparable to those of the Pithecanthropus remains, of the Mauer mandible and the Piltdown fragments. In the following paragraphs I venture to make some comments based upon perusal of the article published in NATURE of February 7.

First of all, the fact that the fragments came immediately under notice of so competent an anatomist as Prof. Dart establishes confidence in the thoroughness of the scrutiny to which they have been subjected. That the history of the specimen should be known precisely from the time of its release from the limestone matrix, provides another cause for satisfaction.

The specimen itself at once raises a number of questions, and, as Prof. Dart evidently realises, these fall into at least two categories. The first question arising out of the discovery is the status of the individual represented by these remains. But the answer to that question, and the presence of such a creature in South Africa, affect other problems. The latter include inquiry into the probable locality of origin of the simian and human types, and the search for evidence of dispersion from a centre, or along a line of successive migrations.

In dealing with the first problem, Prof. Dart has surveyed a considerable number of structural details, and he concludes that the specimen represents an extinct race of apes intermediate between living anthropoid apes and mankind. The specimen comprises the greater part of a skull with the lower jaw still in place (or nearly so). The number and characters of the teeth testify to the immaturity of the individual. The evidence on the last-mentioned point is quite definite, and interest thus comes to be centred in the status assigned to the specimen; namely, that of a form intermediate between the living anthropoid apes and man himself.

Prof. Dart places the specimen on the side of the living anthropoid apes in relation to the interval separating these from man. At the same time, it is claimed that this new form of ape is more man-like than any of the existing varieties of anthropoid apes; and so it comes about that the decision turns on the claims made for the superiority of the new ape to these other forms.

The report shows that (as noted above) many structural details have been scrutinised, and that all accessible parts of the specimen have been examined. The observations relate not only to the external parts of the skull and lower jaw, but also to the endocranial parts exposed to view by the partial shattering of the brain-case. The claims advanced on behalf of the higher status of the specimen are based, therefore, upon a number and variety of such details. Should Prof. Dart succeed in justifying these claims, the status he proposes for the new ape-form should be conceded. Much will depend on the interpretation of the features exhibited by the surface of the brain, as also upon that of all the characters connected therewith; and since Prof. Dart is so well equipped for that aspect of the inquiry, his conclusions must needs carry special weight there. In regard to the brain and its characters, I find the tracing of the contour of an endocranial cast in a gorilla-skull shown in Fig. 6 rather surprisingly flattened, and almost suggestive of the influence of age.

Among the anatomical characters enumerated in the article, some appear to me to possess a higher value in evidence than others. As good points in favour of the claims, there may be cited, in addition to the cerebral features to which reference has just been made, the level of the lower border of the nasal bones in relation to the lower orbital margins, the (small) length of the nasal bones, the lack of brow-ridges (even though the first permanent tooth has appeared fully), the steeply-rising forehead, and the relatively short canine teeth.

On the other hand, I feel fairly certain that some of the other characters mentioned are related preponderantly to the youthfulness of the specimen. Fully to appreciate the latter, demands not only the handling of it, but also thorough survey of a collection of immature (anthropoid ape) crania. The development of the "shelf" at the back of the symphysis of the lower jaw may almost certainly be delayed in some individuals (gorillas). Even the level of the lower border of the nasal bones is subject to some variation, and in young gorillas before the first permanent tooth has emerged fully, that level may be (as in man) above the level of the orbital margin. Generally, the elimination and detachment of features influenced largely by the factor of age demand special attention.

If, however, the good points can be justified, then these characters of youth will not gravely affect the final decision.

However these discussions may end, the record remains of the occurrence of an anthropoid ape some two thousand miles to the south of the nearest region providing a record of their presence. So far as the illustrations allow one to judge, the new form resembles the gorilla rather than the chimpanzee, that is, an African, not an Asiatic form of anthropoid ape. In this respect the new ape does not introduce an obviously disturbing factor. Disturbance, and the re-casting of disturbed views, might nevertheless be caused in two other directions. Thus, the determination of the geological antiquity of the embedding of the fossil remains might have such an effect, were the estimate such as to carry that event very far back in time. Again, a comparison of the new ape with the fossil forms from India (Siwaliks) remains to be made, and it may be productive of results bearing on the relation of the African and the Asiatic groups. In any case, opinion must needs conform to the situation created by this discovery.

If in these notes there have been passed over those observations and reflections wherewith Prof. Dart has illustrated and supported his views, such omissions are not due to want of appreciation, but to lack of capacity and space for their adequate treatment.

Obituary.

MR. OLIVER HEAVISIDE, F.R.S.

BY the death of Oliver Heaviside the scientific world loses one of its most original thinkers. He was born in London on May 13, 1850, and his uncle was Sir Charles Wheatstone, the practical founder of modern telegraphy. The Heaviside family were interested in music and telegraphy. His brother Charles, who lived at Torquay, was connected with the musical industry, and his brother, Arthur West Heaviside, was a superintending engineer to the Post Office and one of the pioneers of radio telegraphy.

After leaving school Heaviside obtained a post with the Great Northern Telegraph Co. at Newcastle-on-Tyne, which he held for several years. During this period he communicated papers to the *English Mechanic*, the *Telegraphic Journal* and the *Philosophical Magazine*. These papers are of more than average ability and show great promise. For example, in 1873 he showed that quadruplex telegraphy was a possibility. Unfortunately, in 1874, increasing deafness made him retire from business life and he went to live in Devon. He now devoted himself whole-heartedly to the study of electricity and its applications. He published many papers which gradually became more and more technical and more and more difficult to understand, as it became necessary, in order to avoid repetition, to assume that the reader knew some of the writer's previous work. Consequently he had difficulty in getting them published in the ordinary technical journals. At that period there were few referees competent to understand them. As a rule they suggested that the paper should be cut down. The result was that many necessary mathematical links were left out, and the expert has no easy task to follow the reasoning. Fortunately, several well-known scientific men—in particular Sir Oliver Lodge, Prof. Perry, and Dr. G. F. C. Searle—had noted the advent of a mathematical physicist of superior ability and helped him to get his papers published. He had, however, to run the gauntlet of a good deal of unintelligent criticism, and none of his discoveries received that immediate recognition which their merit deserved.

Heaviside communicated to the Society of Telegraph Engineers (now the Institution of Electrical Engineers) a paper solving the problem of the electrostatic and electromagnetic interference between overhead parallel wires, a problem which has come to the front at the present time. His methods of measuring mutual inductance published in 1887 are of great value in themselves, and, like most of Heaviside's work, have been most fruitful in suggesting extensions to others. He was the first to solve the problem of the high-frequency resistance and inductance of a concentric main. It would probably have remained neglected for many years had not Kelvin given some of his results in his presidential address to the Institution of Electrical Engineers in 1889.

From the practical point of view, Heaviside's most important work was laying the foundation of the modern theory of telephonic transmission; a theory which has proved a veritable gold mine for the practical telephonist. He pointed out that the difficulties which arose in telephony were due to the different attenuations and different velocities of the various component waves which carry the necessary currents. His theory of the distortionless circuit showed clearly the lines on which telephony could be developed. Working on these lines some ten years later, Prof. Michael Pupin in the United States developed his loading coils, and long-distance telephony was born.

In 1891 Heaviside was elected a fellow of the Royal Society. In 1892 his earlier "Electrical Papers" were published in two volumes. The value of his work began then to be realised by electricians. He did perhaps more than any man to show the value of a knowledge of physics and of mathematical theory in the electrical industry. Pupin has said that Heaviside did much "to introduce the living language of physics in place of the sign language of mathematical analysis." Heaviside's pioneering work will always take a leading place in the history of electrical theory.

The first volume of Heaviside's great work on "Electromagnetic Theory" was published in 1893 and the second volume in 1899. His original intention was to publish the third volume in 1904 and the concluding volume in 1910, but this he found impossible, and so published the third and concluding volume in 1912.

Heaviside was the first to give the theory of the steady rectilinear motion of an electron through the ether, a theory which has been developed by others—notably by Searle—with important results. By an electron he simply meant an electric charge. He pointed out many years ago that even if we knew the constitution of the electron we would be a long way from finality. There is no absolute scale of size in the universe. As it is boundless in one way towards the great, it is equally boundless towards the small. He was one of the first to predict the increase of mass of a moving charge when its speed becomes very great. To verify all Heaviside's reasoning and especially to examine the validity of some of his mathematical methods will provide work for many mathematicians and physicists. He strongly resented the contemptuous tone adopted by some mathematicians when referring to his work on divergent and semi-convergent series. He had found them useful in general theory and for computing purposes, and so he naturally considered his critics prejudiced. In June 1902 he wrote the article on the "Theory of the Electric Telegraph" in the "Encyclopædia Britannica." Many theorems given in this article are constantly quoted by the writers of text-books. In particular his description of what is now called the Heaviside layer, by means of which Hertzian waves are supposed to be bent round the earth, is familiar to every radio engineer.

In the later years of his life Heaviside was one whom every electrical engineer delighted to honour. In 1908 he was elected an honorary member of the Institution of Electrical Engineers. When in 1921 the Faraday Medal was founded, it was universally considered most appropriate that Heaviside should be the first Faraday medallist. The president, Mr. J. S. Highfield, went to Torquay and presented it to him in person. He was an honorary Ph.D. of Göttingen, an honorary member of the Literary and Philosophical Society of Manchester and of the American Academy of Arts and Sciences.

For fifty years Heaviside lived practically a hermit's life at Torquay. He was a good correspondent, but very difficult to approach personally. In his later years Dr. and Mrs. Searle of Cambridge were practically his only friends. The Government gave him a civil list pension, and about twenty years ago Mr. Asquith increased it. The Institution of Electrical Engineers took a filial interest in him, and it is gratifying to remember that during the last few years of his life the Institution kept in constant touch with him. In the preface to his "Electrical Papers" he says that the question "Will it pay?" never interested him. He was, he said, mainly actuated by philanthropic motives. Looking back—as he has probably saved the Government of every large civilised country in the world millions of pounds in the costs of their telephone schemes—he was truly a philanthropist. He died at Torquay on Tuesday, February 3, and was buried on Friday, February 6, in the same grave as his father and mother, only relatives and Mr. R. H. Tree, representing the Institution of Electrical Engineers, being present. Thus ended the life of one who has left a record of work which has proved of great value to the world.

A. RUSSELL.

PROF. N. KULCHITSKY.

THE death of Prof. Nicholas Kulchitsky on January 30, at the age of sixty-nine, has removed one of the foremost of Russian histologists. For many years he occupied the chair of histology at the University of Charkov, where he accomplished most of his researches. His methods of fixing and staining tissues are now in universal use—those for smooth muscle are particularly well known. He devoted much attention and made numerous important observations on the distribution of connective tissue in the intestinal tract and other organs. His text-books of histology are standard works and at present are commonly used by Russian medical students. That his work was well known outside his own country is shown by the fact that he was an honorary member of the Anatomical Society of Great Britain and Ireland.

Prof. Kulchitsky was a man of wide interests and sympathies. He responded whole-heartedly to the request of his government for his expert assistance in the work of the Ministry of Education, and for a number of years he held the post of administrator of education in the Charkov district and later in the Petrograd district. During the period just before the first revolution he held the post of Minister of Education. During the period of upheaval he suffered severely from the hardships attending revolution and counter-revolution: in order to maintain his family and himself he was reduced to hard manual labour. That he was able to live through these hardships, at his advanced age, is evidence of his characteristic power for hard work and perseverance. At length he was fortunate enough to embark on a British refugee ship together with remnants of Wrangel's forces, and this brought him to London, where he found shelter and opportunities for continuing his scientific endeavours.

During the brief time of less than three years, as lecturer in the Department of Histology at University College, London, Kulchitsky was largely concerned with the teaching of students, but he also completed several important and significant researches. Not the least of these is that in which he showed that voluntary muscles are supplied by both medullated and sympathetic nerve fibres, the former being attached to the large muscle fibres, whilst the latter supply small muscle fibres. These facts led to the physiological and clinical investigations of the late Prof. Hunter, who showed that the smaller fibres are responsible for the maintenance of tone in voluntary muscles. The work has found important applications in the operation of dividing the sympathetic nerves supplying the muscles affected in cases of spastic paraplegia.

Prof. Kulchitsky and Prof. J. I. Hunter were associated in their work, and it is indeed a sad coincidence that the untimely death of young Prof. Hunter should so soon have been followed by the unfortunate accident, a fall down an elevator shaft at University College, which led to the death of Prof. Kulchitsky.

The loss of Prof. Kulchitsky is deeply mourned by all his associates and friends at University College and by the scientific world in general. G. V. A.

DR. DAVID B. SPOONER.

THE Archæological Department of the Indian Government has suffered a heavy loss by the death at Agra on January 30 of Dr. David B. Spooner, who had been Deputy Director-General of Archæology in India since 1919 and had acted on one occasion as head of the Survey during Sir John Marshall's absence on leave. Dr. Spooner's connexion with the Department commenced at the opening of the present century, and there can be no doubt that by his own efforts and achievements he did much towards giving practical effect to the policy of conservation and research inaugurated by Lord Curzon in 1902. Up to that date, official efforts to preserve the monuments of past ages and to investigate the hidden remains of antiquity were "spasmodic, desultory, unscientific and planned on a penurious scale." With the appointment of a Director-General of Archæology and a staff of able assistants, among whom Dr. Spooner was deservedly considered one of the most capable, there began that enormous development of historical and archæological study which has been one of the most striking features of the twentieth century in India.

Dr. Spooner did excellent work as Superintendent of the difficult Frontier Circle; but his name is more likely to be remembered in connexion with his excavations at Pataliputra, now known as Patna, the ancient capital of the Maurya dynasty of Magadha, and with the somewhat startling theory which he advanced as to the origin of the family of Chandragupta and his successors. The fact that the palace of the Mauryas, discovered near the modern village of Kumrahar, was almost certainly designed in imitation of the Persian palace at Persepolis, together with other traces of Iranian influence upon the practice of the Mauryan court, led Dr. Spooner to assert that Chandragupta and his successors were of Persian origin. This theory, which he published in the Journal of the Royal Asiatic Society, has been accepted by no one except, possibly, certain Parsi scholars, who were naturally gratified at the idea of a "Zoroastrian period" of Indian history. But while no one disputes the fact that Persian institu-

tions were familiar to the people of northern India in the fourth and third centuries B.C., the assumption of an Iranian origin for the rulers of Magadha has no historical warranty at present, and involves the rejection of important traditional and literary evidence as to their descent.

Dr. Spooner's research work at Kumrahar needs no commendation, and he was probably led into his novel speculations about the Mauryas by his intense enthusiasm—the very quality which, combined with sedulous activity, rendered him so valuable a servant of the Government of India. *Ave atque vale.* S. M. E.

WE regret to announce the following deaths:

Sir Anderson Critchett, Bart., K.C.V.O., surgeon-oculist to the King, first president of the Council of British Ophthalmologists, president in 1894 and 1899 of the Ophthalmological Society of the United Kingdom and in 1913 of the Ophthalmic Section of the International Medical Congress held in London, on February 9, aged seventy-nine.

Dr. Horace T. Brown, F.R.S., distinguished for his work on the chemistry of carbohydrates, on the assimilation of atmospheric carbon dioxide by leaves, and on gaseous diffusion through small apertures, on February 6, aged seventy-six.

Current Topics and Events.

WIDESPREAD interest has been aroused among the general public by the publication of Prof. Dart's account of the discovery of *Australopithecus africanus*, or the Taungs Man, as the Press has elected to call him, in last week's issue of NATURE. Although the discovery dated from November last, the news had been carefully guarded, and it was only when a cable was received in England on February 4, and appeared in the Press on the following day, on the eve of the publication of the article in NATURE, that it became known. Notwithstanding the absence of precise details, the importance of the news was at once recognised by the leading London and provincial daily papers, which quoted freely from Prof. Dart's article as soon as it was available. In another part of this issue, Sir Arthur Keith, Prof. G. Elliot Smith and Dr. W. L. H. Duckworth discuss the significance of the discovery.

THE debt which the modern civilised world owes to science has seldom been acknowledged so generously, or expressed so eloquently, by responsible statesmen as by President Coolidge and by Mr. C. E. Hughes, Secretary of State, in their addresses to the recent meeting of the American Association for the Advancement of Science at Washington, D.C., which have been printed in a recent issue of *Science*. No other single agency, says the President of the United States, has relied so much upon the work of men and women of science as has his government, which has been foremost in employing and most liberal in endowing science, although it cannot claim to have been "impressively liberal" to the scientific workers whom it has employed. The scientific work done under the administrative departments has, he says, been of enormous value to the whole people. Men of science are "the wonder-workers of all the ages"; the discoveries made by them have become commonplaces because their number has paralysed the capacity of the mind for wonderment. Representatives of social and political organisations regard the march of science with awe, and sometimes with fear, when they ask themselves what will be the next revolution to which their schemes will have to be adapted; but the conviction that science works for the public weal, and that at the worst it saves life from being very monotonous, restores their confidence. It has taken endless ages to create in men the courage that will accept the truth simply because it is the truth. Comparatively few men are sufficiently gifted to be able to use the scientific method in seeking for the truth, but they no longer fear the results to which it leads. Truth is essential, and therefore all encouragement should be given to men of science and of faith.

MR. HUGHES spoke on the value of science in promoting international co-operation and concord. Science may forge new and terrible weapons of destruction, but she is far more eloquent as she points to the wastes of strife, to the retarding of progress, and to the vast opportunities which are open to those peoples who will abandon mutual fears and destroy artificial barriers to community of enterprise. Each nation should collect, collate, and safeguard all data and records made within its territory, and should make them readily available to other nations. International co-operation in research is absolutely necessary, and both national research organisations and the International Research Council are doing good work and opening up a new era of international co-operation in science. Scientific method is needed in government, in making and administering the law. The scientific attitude of mind is needed because it comprises search for pure knowledge, distrust of phrases and catchwords, hatred of shams, willingness to discard outworn beliefs, and, above all, faith in humanity and zeal for the public good.

THE Right Hon. T. R. Ferens, High Steward of Hull, has presented to Hull the princely sum of 250,000*l.* as a nucleus towards a University College for the city. In his letter to the Lord Mayor announcing his intention of making the gift, Mr. Ferens stated that he had carefully consulted university professors and others interested in educational matters, and was satisfied that the time was arriving when Hull should join other cities, such as Birmingham, Manchester, Liverpool, Leeds, etc., in giving opportunities to its sons and daughters for higher education. We believe it was at the meeting of the British Association at Hull, when the retiring president, Sir Edward Thorpe, and the president, Sir Charles Sherrington, were the guests of Mr. Ferens, that the idea was first suggested. In addition to this magnificent gift, a new Art Gallery, costing something like 90,000*l.*, together with its site in the centre of the city, has been presented by Mr. Ferens.

He has given more than 11,000*l.* towards pictures for the permanent collection, without which the probability is the present Art Gallery in the City Hall would not have existed. Other gifts of Mr. Ferens include more than 9000*l.* for the site for a new technical college, amounts set aside for scholarships, playing fields, almshouses, boating-lake, and similar objects.

LONGEVITY among scientific men is exemplified in a signal manner through the ninetieth anniversary of the birth of a distinguished zoologist, the Rev. T. R. R. Stebbing, F.R.S., an event which occurred on February 6, and was duly celebrated at his home at Tunbridge Wells. The record of the Stebbing family with the Royal Society, from father to son, is noteworthy when we recall that 1765, 1845, and 1896 are, respectively, years of family elections into that body. Born in London, Mr. Stebbing was the fourth son of the Rev. Dr. Stebbing, many years acting editor of the *Athenæum*, indeed almost from its foundation in 1828. Incidentally, we may remark that the third son, Mr. William Stebbing, for long Delane's right-hand man on the staff of the *Times*, is also alive. Mr. Stebbing's life studies in zoological science have been concerned principally with the Crustacea. His report upon the Amphipoda of the *Challenger* Expedition occupies three quarto volumes, comprising 1774 pages of letterpress and 212 plates. It was accompanied by a bibliography giving a critical report of everything that had been written respecting these Crustacea from the time of Aristotle to the year 1887. This detailed analysis occupies more than 600 pages, being in fact a complete history of the group. Mr. Stebbing has always been greatly interested in promoting local scientific societies. His efforts in this connexion in the south-east of England, jointly with the late Mr. George Abbott, were referred to in NATURE of February 7, p. 201. Mr. Stebbing was zoological secretary of the Linnean Society, 1903–1907, and Linnean medallist, 1908. We proffer our heartiest congratulations to him upon the auspicious occasion of a nonagenarian birthday.

DR. J. H. JEANS gave the sixteenth Kelvin Lecture to the Institution of Electrical Engineers on February 6. He chose as his subject electrical forces and quanta, and gave a masterly résumé of the theories of relativity and quanta. Starting with Einstein's hypothesis he stated that the whole theory of gravitation and of electromagnetic forces can be worked out by pure geometry. When, however, we come to the theory of quanta we have to determine the magnitude of the quantum, and so it is necessary to have recourse to experiment. He considers that there is now no room for doubt as to the substantial accuracy of Einstein's relativity theory. It provides a general dominating principle, to which all phenomena must conform. It helps us to discover the laws according to which events occur, but has nothing to do with why they occur. It is unscientific to suppose an ether unless there is an absolute necessity for it. The hypothesis is unnecessary, in Dr. Jeans's opinion, as the explanations are entirely satisfactory without it. *A fortiori* it is hopelessly unscientific to presuppose two or more ethers. In his opinion the last twenty-five years will rank as one of the most fruitful and important periods in the history of physics. In an hour the lecturer covered a very wide field. He touched on Rutherford's, Bohr's, and Sommerfeld's theory of the atom. He pointed out that the explanation of line spectra is one of the most satisfactory in the whole range of physics, the numerical accuracy of the theory rivalling the most accurate of astronomical calculations. He is of opinion that the theory of a mechanical ether believed in by Faraday and Maxwell is dead. As soon as we pass beyond the minute range covered by the Newtonian mechanics and the classical electro-dynamics, the picture presented to us by the quantum dynamics takes us by surprise. We find that Nature consists of a series of abrupt jumps. These jumps are so minute and so close together that they produce the illusion of continuous motion, and no satisfactory mechanical explanation has yet been given.

THE fourth annual report of the British Electrical and Allied Industries Research Association has now been published. It is stated that the results obtained last year represent a real contribution to progress in the affected industries, but nothing of a spectacular character has been discovered. Hitherto commercial research has been concerned mainly with the finding of the values of physical constants. Little has been done in the way of obtaining new scientific knowledge. It is stated that the discoveries of Sir J. J. Thomson and Sir E. Rutherford are opening up immense fields of knowledge which may not only revolutionise existing methods of design but even alter the nature of the activities of the whole industry. The Association is giving close attention to the possibilities of work in this direction. It is considered, for example, that there is necessity for fundamental research on a large scale into the phenomena of dielectrics. This of course is of great interest to the cable and therefore to the whole electrical industry. We shall be very interested to note the results of these great schemes of co-operative research.

THE late Mr. Thomas L. Gray, who died about a year ago, bequeathed the residue of his estate, which is expected to amount to about 7000*l.*, to the Royal Society of Arts for the purpose of founding a memorial to his father, Thomas Gray, formerly head of the Marine Department of the Board of Trade. According to the Society's journal, the bequest is to be known as "The Thomas Gray Memorial Trust," and the income derived from it is to be devoted to "the advancement of the science of navigation and the scientific and educational interests of the British Mercantile Marine." It is suggested in the will that these objects may be achieved by offering prizes for new inventions relating to navigation, by making grants for scientific research and for lectures on the subject, and by providing scholarships for students or teachers and offering prizes for essays on and awards for the saving of life at sea. Thomas Gray

was in charge of the Marine Department during the 'seventies and 'eighties, when British shipping was developing rapidly, and took a prominent part in formulating the present system of regulation and control.

THE issue of *Die Naturwissenschaften* for January 16 is devoted to an account of the foundation on January 14, 1845, of the Physikalischen Gesellschaft of Berlin by Profs. Beetz, Brücke, Karsten, Knoblauch and Du Bois-Reymond, and its subsequent history. Profs. Warburg, Goldstein, Scheel, Pringsheim and Planck are responsible for an interesting and well-illustrated account of the Society and its activities. The five founders are shown in the frontispiece, which in itself makes an interesting study of professorial attire. Profs. Clausius, Quincke, Kundt and Kohlrausch form another group, and separate portraits are given of Profs. Riecke, Warburg, Brücke, Kirchhoff, Helmholtz, Halske, Weierstrass, G. Wiedemann, Kronecker, Schwalbe, Werner Siemens, Hagenbach, von Bezold, Foerster, Planck and Goldstein. As the Society developed out of the physical colloquium founded by Prof. Magnus in Berlin in 1843, it is fitting that Prof. Pringsheim's recent address to the Society on the Magnus effect, its theory as developed by Prof. Prandtl and its application by Dr. Flettner, should be given a prominent place and that the original figures of the Magnus paper should be reproduced.

THE final sale of the Crisp collection of microscopes takes place on Tuesday, February 17, at Stevens's Auction Rooms, where in 1920 and 1921 the other portions of the collection were sold. In the catalogue which Messrs. Stevens have issued, 371 lots are detailed, arranged in groups :—(1) Simple microscopes and small pocket compound microscopes; (2) compound microscopes dating from the seventeenth century to the introduction of achromatism in the early part of the nineteenth century; (3) optical cabinets, solar and projection microscopes. The various Nuremberg wooden microscopes form another small group. In each group, the instruments are catalogued approximately in chronological order. Illustrations are given of fourteen of the earlier and more interesting instruments, including the unique silver microscope made by G. Adams, a Hooke microscope, and original examples by Campani, Marshall, and Lindsay. The whole collection, which consisted of about 3000 microscopes, was formed during the latter half of the last century by the late Sir Frank Crisp, Bart., who became the leading authority on the history and development of the instrument. He frequently expressed his intention of presenting his collection to the Science Museum at South Kensington, so that it might become the property of the nation.

AT a meeting of the Dominions and Colonies Section of the Royal Society of Arts on January 27, Mr. W. R. Dunlop, lately professor of economics under the auspices of the Colonial Office, read a paper entitled "Economic Research in Tropical Development." Starting from the premise that the great question of economics is why some people, individually or collectively, are better off than others, Mr. Dunlop said that useful and illuminating results can be obtained in the tropical world, by contrasting one country which is undeveloped and poorly off with another that is relatively highly developed and extremely well off. Taking British Guiana in South America, and British Malaya in the East, the total population and external trade of the former in 1923 were 300,000 and 6,426,607*l.*, while those of the latter were 3⅓ millions and 147,945,860*l.* As countries go, both are similar in size (comparable to the area of the United Kingdom), both are fertile, and both have mineral and other resources. The difference in extent of development is fundamentally due to (*a*) difference in world geographical position, (*b*) difference in mineral resources, (*c*) internal geographical disadvantages in the case of British Guiana. On the whole, British Malaya is also more efficient industrially than British Guiana. Concerning efficiency in public administration, Mr. Dunlop directed attention to the fundamental importance of transport, public health, land administration, forestry and scientific research of all kinds in tropical economic development. Comparison of existing policies in these matters in British Guiana and British Malaya shows striking differences. In conclusion, Mr. Dunlop said that he used British Guiana and British Malaya as illustrations providing data and proof for demonstrating the nature of the research he was advocating.

APPLICATIONS are invited for some junior professional assistantships at the Meteorological Office. Candidates must hold an honours degree in mathematics or physics. Written applications should be addressed to the Secretary (S. 2), Air Ministry, Adastral House, W.C.2.

THE Royal Aircraft Establishment, South Farnborough, Hants, is requiring a test assistant for aerial photographic work. Candidates should possess some knowledge of chemistry, preferably photographic chemistry, and be medically fit for flying. Applications should be marked A. 46 and be sent to the Superintendent of the Establishment.

SIR OTTO BEIT, Bt., F.R.S.; Sir Sidney Frederic Harmer, F.R.S., Director of the Natural History Departments, British Museum; and Sir Frank Short, Royal Academician, president of the Royal Society of Painter-Etchers, have been elected members of the Athenæum under the provisions of Rule II. of the Club, which empowers the annual election by the committee of a certain number of persons of distinguished eminence in science, literature, the arts, or for public service.

SHORTLY before 10 P.M. on February 1, a slight earthquake was felt in the south-west of Cornwall, at Penzance, Camborne, Truro, etc., and the Scilly Isles. Records have also come from Brest and Jersey. The disturbed area probably contained about 17,000 square miles, and its centre apparently lay to the west of the Channel Islands. In the much stronger earthquakes of January 28, 1878, and May

30, 1889, the centre lay to the east of Jersey. It has been suggested that the shock was due to the subsidence of disused mine-works, but the greatest known area disturbed by such earth-shakes is less than 150 square miles, and, owing to the small depth of the origin in such cases, the intensity is always great near the centre of the area and declines rapidly outwards.

AT the annual meeting of the Royal Microscopical Society held on January 21, the following were elected as officers and members of the Council for the ensuing year: *President*, Mr. A. Chaston Chapman; *Vice-Presidents*, Prof. F. J. Cheshire, Mr. M. T. Denne, Sir Robert A. Hadfield, Bart., Dr. R. J. Ludford; *Treasurer*, Mr. C. F. Hill; *Honorary Secretaries*, Mr. J. E. Barnard, Dr. J. A. Murray; *Members of Council*, Mr. S. C. Akehurst, Mr. E. W. Bowell, Rev. Canon G. R. Bullock-Webster, Dr. H. G. Cannon, Dr. C. Da Fano, Mr. E. H. Ellis, Prof. R. Ruggles Gates, Mr. T. H. Hiscott, Mr. J. W. Ogilvy, Mr. D. J. Scourfield, Dr. C. Tierney, Mr. H. Wrighton; *Librarian*, Mr. R. Paulson,; *Editor*, Dr. J. W. H. Eyre; *Curator of Instruments*, Mr. W. E. Watson Baker; *Curator of Slides*, Mr. E. J. Sheppard.

AT the last meeting of the Illuminating Engineering Society on Jan. 27, a paper was read by Mr. J. W. T. Walsh, of the National Physical Laboratory, Teddington, dealing with some little-understood aspects of the effect of shadows in lighting problems. It is well known that the shadows cast by indirect lighting systems—for example, when light is received by reflection from a white ceiling—are so soft as to be inappreciable to the eye. In fact such systems have sometimes been described as "shadowless." Mr. Walsh was able to show that what the eye cannot perceive the photometer can detect, and that in fact the obstruction of light by a person's body or adjacent machinery, etc., may in such cases cause a very marked diminution in the available illumination. Similar conditions apply when one is dealing with daylight from a white sky, yielding ill-defined shadows. Methods of calculating the ensuing loss of light were suggested. An interesting example of such effects was afforded by a room with white walls and ceiling which, when empty, appeared to be brilliantly illuminated; but when the room was occupied by bulky, dark-coloured machinery the illumination was found to be inadequate. At the conclusion of the meeting it was mentioned that a special course of lectures, each given by an expert on some special aspect of illumination, is being arranged to take place at the Polytechnic, Regent Street, starting in April next.

WITH its January issue *The Marine Observer* has entered upon its second year. The former Director of the Meteorological Office, Sir Napier Shaw, contributes an interesting communication, "A Meteorologist at Sea," a reflection on meteorology when traversing the Atlantic for the recent British Association meeting in Canada. The reflection roughly compares official meteorology as undertaken by Admiral Fitz-Roy in 1855–1865 with official meteorology as controlled by Sir Napier from 1900 until 1924. At the commencement of Sir Napier's official career at the Meteorological Office, a quarter of a century ago, weather observations were obtainable only at the central weather offices of different countries, and the area embraced was very much limited. Now the daily map obtained embraces practically the whole of the Northern Hemisphere. It is only a little more than 60 years ago that charting the weather on daily maps was introduced into Great Britain by Admiral Fitz-Roy. Much information is given in the periodical bearing on ships' wireless weather news, by means of which every opportunity is afforded seamen of constructing their own weather charts when at sea.

IN the January issue of *Science Progress* Mr. F. W. Shurlock, Principal of Derby Technical College, gives an account of the Rev. A. Bennet, F.R.S., curate of Wirksworth, near Matlock, and inventor of the gold leaf electrometer. Unfortunately, the "Dictionary of National Biography" gives no account of Bennet and ascribes the invention of the instrument to George John Singer. The "Encyclopædia Britannica" and Wiedemann's "Elektricität" both give the credit to Bennet, and cite his paper in the Transactions of the Royal Society for 1787, in which the instrument is described. It is dated "Wirksworth, Sept. 14, 1786," and as Singer was born in this year there can be no question of priority. Mr. Shurlock quotes the description of the instrument, the method adopted for getting an electric charge from the air by means of a flame and the method of doubling the charge obtained. Bennet's Royal Society papers form the basis of his book, "New Experiments on Electricity," published at Derby in 1789. He appears to have been a master at the Free Grammar School at Wirksworth, and there is a quaint portrait of him in the vestry of the parish church. He became rector of Fenny Bentley near Ashbourne in 1796 and died there in 1799.

THE "Arcadia" projector, shown in operation at the King's Cross Cinema on February 4, has several novel and distinct features. Hitherto the projection of "living pictures" has been based on the use of an automatic shutter alternately opening and closing, and presenting a rapid succession of "still" effects. The shutter causes a rapid alternation of light and darkness and is liable to cause more or less flicker. The new projector makes use of a complex arrangement of rotating mirrors, whereby successive pictures are imposed, but throughout the process there is substantially the same amount of light on the screen, and it is claimed that this removes one potential cause of eye-strain. In addition the method gives rise to a certain degree of stereoscopic effect. The mechanism of the projector and the method of feeding the film also present novel features, conducive to greater steadiness and more silent running, and the amount of wear and tear of the film is stated to be very much reduced. A similar projector was demonstrated at the Imperial College, South Kensington, on February 10, 1921, and described in our issue of February 24, 1921, p. 841.

THE recently amalgamated firms of T. Cooke and Sons, Ltd., and Troughton and Simms, Ltd., 3 Broadway, Westminster, S.W.1, which went into voluntary liquidation several months ago, inform us that this state of affairs has now been satisfactorily terminated. They wish it to be known that their facilities for designing and manufacturing high-grade scientific instruments and apparatus in large quantities have been retained intact, so that they are able to deal with orders as hitherto.

MESSRS. Adam Hilger, Ltd., have recently issued a handsome catalogue of their various manufactures. It includes thirteen sections and is provided with a thumb index for ready reference as well as a general index at the end. The instruments described and illustrated in the sections come under the following headings:—Echelon diffraction gratings and Lummer-Gehrcke parallel plates (including echelon gratings having as many as 56 plates); spectrometers and goniometers; wave-length spectrometers, monochromators and specialised spectroscopes; spectrographs; accessories for spectrometers and spectrographs (including, among other things, heliostats, vacuum tubes, thermopiles and high purity electrodes of copper, iron, carbon and nickel); spectrophotometers, colorimeters, and apparatus for sensitometry (including the new Judd Lewis sector photometer); diffraction gratings; micrometers, etc.; polarimeters and refractometers; Michelson, Fabry and Perot, and Hilger interferometers; spectroscopic apparatus for high resolving power; optical work; and the Low-Hilger audiometer. The instruments are well described and appear to be constructed with the care and with the view of convenience in use for which this firm is well known. It is unfortunate that they cannot be produced at a lower price, however, as many to whom they would be of great value will find some of the charges prohibitive.

MESSRS. Gallenkamp and Co., Ltd., of 19 Sun Street, Finsbury Square, London, are to be congratulated on the new issue of their catalogue of apparatus for the examination of soil. Until now, the recent striking advances in the technique of agricultural science, especially in physics and physical chemistry, have not induced the scientific apparatus firms and instrument makers to introduce the new apparatus to general notice. This has been a real disadvantage to the research worker in soils. It has usually been possible to persuade a firm to make a copy of some particular apparatus, the construction of which was beyond the ordinary laboratory facilities, but this is a very expensive way, as all the special costs are chargeable to the one apparatus. On the other hand, when an apparatus is listed in a catalogue, not only does it bear a smaller share of the overhead charges, but the publicity usually results in increased sales, which act in the same direction. Messrs. Gallenkamp's catalogue is divided into five sections: soil sampling tools, physical properties of soil, soil solution, chemical analysis of soil, and soil meteorology. Each of these sections contains items that well show the recent advances in the technique of agricultural science. The newer forms of soil sampling tools are to be commended, and in the sections on physical properties of soil and soil solution, prominence is given to apparatus devised at the Rothamsted Experimental Station. The section on soil meteorology has been carefully thought out and should be of considerable use in the development of work that, coming on the border line between meteorology and soil physics, has been rather neglected.

MESSRS. Longmans and Co. have in preparation a new and cheaper edition of Thorburn's "British Birds." The work will be in four volumes, illustrated by 192 coloured plates reproduced from new drawings by the author. It is hoped to issue the first volume in March, the second in the autumn, and the remaining two volumes in 1926.

SOME 1900 books on geology, palæontology, and mineralogy from the libraries of the late Sir Jethro J. H. Teall, and Messrs. T. W. Reader and E. A. Walford, are offered for sale in Catalogue No. 123 by Messrs. Dulau and Co., Ltd., 34 Margaret Street, W.1, together with a number of other works on fossil plants, anthropology, archæology, and zoology. Copies of the catalogue can be obtained on application.

Our Astronomical Column.

PHOTOGRAPHY OF THE ASTRONOMISCHE GESELLSCHAFT ZONES.—Prof. Schlesinger gave an interesting account at the meeting of the Royal Astronomical Society on Jan. 10 of the reobservation by photography, at Allegheny Observatory, of some of these zones. The novelty of the method lies in the size of the plates used, some of which are 5° in the side, others 12½°. The lens is a triple one, and the only form of distortion present is a tendency for bright stars to appear slightly displaced away from the centre as compared with faint ones; the amount near the edge is 0·06″ per magnitude. As each star is present on at least two plates, with the shift generally in opposite directions, no systematic magnitude error is introduced.

Although the scale is only half that of the Astrographic plates, the excellence of the lens is such that the probable error of each star image is only 0·18″.

Incidentally, the measures give the means of determining magnitude error in the Astr. Gesell. Catalogues. For on plotting the differences of R.A., Allegheny *minus* A.G., for different magnitudes, the abscissa being Right Ascension, sine curves are obtained due to the solar motion. The zero line of these curves is found to alter with the magnitude; now as magnitude equation on the photographs is shown to be eliminated in the mean, the effect must be due to the equation in the A.G. Catalogues.

Prof. Schlesinger is on his way to South Africa to inaugurate the photographic work with the instrument which is being sent there from Yale Observatory. He hopes to return in time for the meeting of the Astronomical Union at Cambridge in July. It may be mentioned that the 12½° × 12½° plates are a quarter of an inch thick and weigh 10 lb. It would only need some 270 of these plates to cover the entire celestial sphere, so that the taking of the plates is a much less serious matter than that involved in the Astrographic Catalogue. The chief labour lies in the measurement and reduction.

Research Items.

THE PRESERVATIVE PROPERTIES OF HOPS.—For many years it has been assumed that the preservative properties of hops are directly proportional to the percentage soft resin content. In view, however, of the objections inherent in Brown's method of evaluating the former, it is welcome to find in a recent paper by Mr. A. Chaston Chapman (Jour. Inst. Brew., 1925, xxxi. 13) the description of an improved biological method. To varying amounts of a 1 per cent. aqueous infusion of the hops, in a medium of nutrient agar, were added a few drops of a culture of an organism isolated from raw sugar, and specially sensitive to the inhibitory effects of hop extract. After incubation for 18 hours at 37° C. on petri dishes, the mixtures were arranged in order of bacterial development, the end-point being represented by a dish containing few or no colonies, followed by one containing a large number. The end-points were sharp and concordant, and within reasonable limits, were independent of the strength of the infusion and of the number of successive digestions of the same sample. The author suggests that the preservative material, though highly insoluble, is being produced continuously during the extraction. Whereas no quantitative connexion between the soft resin content and the preservative value is apparent, experiments on the cold and ordinary storage of hops show that both these properties diminish at a slower rate in the former case. Apparently the two properties are associated in some way not yet clear, the quality rather than the quantity of preservative material being the important factor. Methods of estimating resin content by direct extraction are criticised, and an improvement giving higher results is suggested for soft resins. These are now extracted in a Soxhlet apparatus by petroleum ether from the total resin solution spread on an Adams milk-analysis paper.

DETERIORATION OF STRUCTURES IN THE SEA.—The fourth (interim) report of the Committee of the Institution of Civil Engineers on the Deterioration of Structures in Sea-water was published in December 1924, although the report itself is dated September 1923 and deals, for the most part, with investigations carried out in 1922. It includes a paper by Mr. E. J. M'Kaig and Dr. J. Newton Friend describing a steel landing-stage at Weston-super-Mare which, after standing for fourteen years, developed structural defects and had to be taken down. One point of interest was the unexpectedly large amount of corrosion at the point where the piles entered the sea-bottom, due, apparently, to the slow drift of sand against the piles. Other evidence also suggests that a very slight amount of mechanical wear greatly accelerated the chemical action of the sea-water on the steel. Investigations relating to the preservation of timber from marine boring animals are reported on by Prof. G. Barger and Mr. C. M. Yonge. As the work of the latter only extended over a period of six weeks, it was scarcely to be expected that much would be added to our knowledge of the life-history of Teredo. The results of experiments in poisoning the larvæ with the arsenic compound "D.M." are in striking contrast to the American observations recently reviewed in NATURE (November 22, 1924, p. 745). The species studied at Plymouth by Mr. Yonge was identified as *Teredo norvegica*; Prof. Barger does not give the name of the species which he observed at Lowestoft, but as he refers to "Teredo" as a "species," it is plain that he does not consider the point of much importance. An account is given by Mr. J. M'Glashan and the late Dr. N. Annandale, of damage done to brickwork in the Calcutta docks by the boring mollusc *Martesia fluminalis*. It should have been mentioned that Dr. Annandale's report printed here was published more than a year ago in the Journal of the Asiatic Society of Bengal (vol. xviii. No. 10, p. 555).

EXTINCT RHINOCEROSES OF CHINA.—The Geological Survey of China has published an important work by Dr. Ringström of Upsala on the Rhinoceros and Hipparion Fauna of North China (Provinces of Shansi, Shensi, and Honan). The present volume is part iv., series C of volume i., 1924, and deals entirely with the rhinoceroses. In it a new genus of the short-legged teleocerine rhinoceroses is described under the name Chilotherium. A new genus of great interest, Sinotherium, of which Ringström had already published a preliminary account, is also here more fully described. The genus is closely allied to Elasmotherium, that curious rhinoceros with extraordinary complicated teeth and large hump over the eyes and nose, of which the British Museum has recently acquired a fine skull. The paper is fully illustrated with many text-figures and twelve plates, and its value is further enhanced in that the author gives his views on the position of certain Asiatic and European rhinoceroses.

AN AMERICAN EXTINCT FAUNA.—A bulletin of the American Museum of Natural History (vol. 50, article 2) contains a third part of Dr. W. D. Matthew's studies on the Snake Creek fauna. In it will be found a short notice of the stratigraphy of these important Miocene and Pliocene quarries whence the specimens came, together with remarks on the distinctions between the faunal zones and correlation of the faunas. The list of the vertebrate fauna, numbering more than a hundred species of mammals and including the celebrated tooth of *Hesperopithecus haroldcookii*, together with a sprinkling of birds, reptiles, and amphibia, is an impressive one. The bulk of the paper is devoted to an account of the various forms and, as is usual with this author, is no mere dry description, but is illuminated throughout by his discussion and views as to the evolution and relationship of the various forms, such as the phylogeny of the Canidæ and questions concerning the horses.

THE METEOR CRATER OF ARIZONA.—The Indians of Northern Arizona have a legend that a god visited them from heaven in a great chariot of fire which illuminated the sky and finally disappeared into the ground. It seems probable that the chariot was the gigantic meteorite which has been held responsible for the origin of the remarkable crater of Canyon Diablo. That the impact theory is correct seems to be established by the work of D. M. Barringer (Proc. Acad. Nat. Sci. Philadelphia, 1924, p. 275). He predicted in 1909 that the main bulk of the meteorite would be found under the southern wall of the crater. An exploratory boring has now been sunk near the southern rim, and at a depth of 1346 ft., highly oxidised meteoric iron was met with. After passing through 30 ft. of this material the tools jammed, and no further progress was possible. Barringer considers the main meteorite approached the earth from the north at an angle of roughly 45°, leaving a scattered trail of the well-known Canyon Diablo meteorites. These have been found to contain platinum, and according to the *Winslow Mail*, of Arizona, a company has now been formed

to mine the deeply buried mass, which has been estimated to weigh a thousand million tons, by running drifts into it from the low country to the south of the crater rim. The unique history of Meteor Crater should therefore be gradually disclosed during the next few years more completely than could ever have been anticipated before the possibility of platinum suggested mining exploitation.

PETROLEUM: ITS GENESIS AND GEOLOGY.—An article from the pen of Prof. James Park and bearing this title appeared in the September number of the New Zealand Journal of Science and Technology (1924); it presents a very fair résumé of the subject, though it was obviously written for the purpose of general knowledge rather than to pave the way for possible oil explorations within the Dominion. From the tectonic point of view New Zealand, as is the case with Australia, does not offer inducement as a country of potential petroleum reserves, though evidence of oil is by no means lacking; this does not, however, imply accumulation on a commercial scale. The author makes the interesting statement that "The seepages of oil found at Taranaki, and at Waiotapu in the King-country, New Zealand, occur in Tertiary rocks; and there is good reason for the belief that the oil has originated from the destructive distillation of the underlying seams of lignitic coal." This theory, even if well founded, tends to make it all the more improbable that there is any economic future for oilfield development in this country. This is the only specific reference to petroleum in New Zealand. In the paragraphs discussing the general geology of petroleum, the author refers to the porosity of oil-sands and states that "a porosity of 10 per cent. is equal to 750 barrels of oil per acre-foot. The recoverable oil ranges from 50 to 75 per cent. of the oil in the sands." This last sentence is open to some doubt, especially with present-day methods of oil production; in practice a 30 per cent. recovery is considered good; Uren places the maximum at about 40 per cent., and with a 25 per cent. porosity and complete saturation this could probably be achieved. Writing of oil migration, the author attributes this to "the differences of the specific gravities of oil and water" as being "the most powerful cause"; the researches of Munn and others have demonstrated clearly that movement and pressure of underground water are far more potent causes, as, indeed, may be gas pressure and capillary attraction. The article is, on the whole, a curious mixture of orthodox statement and original comment; it is in many respects to be regretted that the author does not also give us a fuller description of the known occurrences of bitumen in his country, notwithstanding that they may have little commercial value.

SOME USES OF PEAT.—One commonly regards peat in domestic use as a form of clean, cheap, though not always very efficient fuel, and such it probably is in most countries. It may come as a surprise to some people, therefore, to learn that in that land of varied and abundant fuels, the United States, by far the greatest quantity of peat produced is utilised in the form of fertilisers or as an ingredient of fertilisers, no less than 57,907 tons being marketed for this purpose in 1923, at a gross value of 351,641 dollars. The bulk of the United States peat comes from Illinois, New Jersey and California contributing the second and third largest outputs respectively. The use of peat as a stock-food is the next important activity in the industry, more than 3000 tons being produced for this purpose in the same year. As a fuel, the production (hence consumption) was practically negligible; in fact no return was made at all for 1923, and only 1040 tons were thus absorbed in the previous year. Other uses (according to Mr. K. W. Cottrell in Mineral Resources of the United States for 1923, part 2) include its employment as peat moss, stable litter and packing material, much of which is included under the annual return for stock-food. A somewhat curious fact is that peat moss imported for consumption in the United States has shown a steady increase during five years from 1919, when 464 tons were introduced, to 1923, when nearly 600 tons at a value of 43,184 dollars were imported, presumably from northern Europe, where the Sphagnaceæ are important constituents of peat. Peat rich in these mosses has in other countries been successfully used in the manufacture of blankets, rugs, cardboard and cork-like materials, and it may be that some such use is being found for it in the United States, though the present report makes no mention of the purpose for which peat moss is being imported.

RESOURCES OF ARCTIC RUSSIA.—Under the Scientific-Technical Department of the Supreme Council of National Economy, Transactions of the Northern Scientific and Economic Expedition, Petrograd and Moscow, 1920–1924 (*in Russian*), are published the results of several expeditions for the exploration of natural resources of Arctic Russia. The publication appears in separate parts, each one dealing with a special problem. Most of the work has been directed towards the exploration of the mineral wealth of the country, and many important discoveries are recorded. Thus the report by I. I. Ginsburg (No. 7 of the Transactions, pp. 64) contains an exhaustive survey of the mineral resources of the coasts of the Kandalaksha Gulf of the White Sea, where gold has been found and extensive beds of mica have been studied; local silver and lead ores are also described, and sketch maps of mineral resources are given. No. 18 of the Transactions (pp. 75, 1924), by Beliankin and Kupletsky, and No. 20 (pp. 43, 1924), by Beliankin, Vlodavez, and Shimpf, contain further information on the mineral resources of the same territory collected during the expeditions of 1917 and 1922 respectively; these two papers include also considerable data on petrography and geology of the country. No. 16 of the Transactions, by A. Fersman (86 pp., 1 map, 1923), includes a series of abridged reports of different authors on the results of expeditions to the Khibin ridge of the Kola peninsula, where a very extensive geographical, geological, and geochemical survey was organised during the years 1920, 1921, and 1922; full reports of the expeditions will be published in two volumes when all the materials collected are worked out. Paper No. 19 (pp. 102, summary in English), by Prof. K. N. Derjugin, presents results of exhaustive hydrological and biological exploration of the Barents Sea during the years 1921–1923. The author gives new evidence to prove that, besides the annual oscillations of temperature of water, there exist periodic variations in the Atlantic currents which appear to be subject to a cycle of 8-9 years. Other hydrological elements, distribution of salinity and of oxygen, degree of transparency of water and character of ground, are also discussed. Lists of fauna are given (including descriptions of several new forms), and the conclusion is reached that the fauna of the Barents Sea is not arctic, but only sub-arctic, in its composition. The authors believe that periodical variations in the thermical state of the Barents Sea have a strong influence on the climate of Northern Europe.

WEATHER IN RHODESIA.—The Proceedings of the Rhodesia Scientific Association, vol. xxii., contains a discussion on "The Problem of Seasonal Forecasting," by Mr. C. L. Robertson. The method of

cycles is dealt with, but the longest local record available is only continuous for 35 years, which is quite insufficient. Severe droughts are said to occur within a year or two of sunspot minima and heavy rains within a year or two of sunspot maxima. A 19-year cycle, based on pressure variations, is suggested as influencing Rhodesian weather. Maps are given showing the variations of pressure over the globe for the months of February, May, August, and November. Reference is made to the pressure values in the southern hemisphere to show the relation to Rhodesian weather. Areas of high pressure, important centres of action for South African weather, are shown in the South Indian, South Atlantic, and South Pacific Oceans. There is a movement of these centres to the north and south, and also to east and west. The tracks are said to deviate from an average mean track, and the 19 years' periodicity is attributed to this movement. Much detail is given with reference to the various cycles, and the inquirer will find much of interest. A connexion is referred to between the south-west monsoon rainfall in India and the rainfall along the east coast of Africa down to Rhodesia. Based on the assumptions obtained, seasonal forecasts are being made and probably in time some success will be gained.

HYDRODYNAMICS AND ELECTRICAL ANALOGIES.—In the December issue of the *Journal de Physique*, Prof. V. Bjerknes shows how the general equations of hydrodynamics may be transformed so as to exhibit the close analogy between the movements and forces in the fluid and the currents and forces in electrodynamics. By means of rotating cylinders, and arrangements for producing bodies the volumes of which pulsate about a mean value, or oscillate about mean positions, he has shown that the analogy is true experimentally. He points out that both his theoretical and his experimental work are but generalisations and improvements of results published by his father forty-five years ago. Amongst the analogous systems referred to by the author may be mentioned the lines of flow about a pulsating sphere and the lines of force about a magnetic pole, the lines of flow due to an oscillating sphere and the lines of force of a short magnet, the lines of flow due to two parallel cylinders rotating in opposite directions and the lines of force due to two parallel electric currents flowing in opposite directions, a cylinder rotating in a stream of fluid (the Magnus effect) and a wire carrying electric current in a magnetic field.

HEATS OF OXIDATION.—The heats of oxidation of certain metals in a pure state have been redetermined by J. E. Moose and S. W. Parr (J. Amer. Chem. Soc., Dec. 1924). A very accurate bomb method was used. The values, in calories per gram of metal, for some of the more important metals are: aluminium, 6970; beryllium, 14,879; zinc, 1298; magnesium, 5996; cerium, 1661.

ISOLATION OF HYDROXYLAMINE.—C. de W. Hurd and H. J. Brounstein, in the Journal of the American Chemical Society for January, describe a new method of isolating free hydroxylamine from the hydrochloride. The latter is decomposed with a butyl alcohol solution of sodium butylate; the sodium chloride is filtered off and the filtrate cooled to $-10°$, when half the hydroxylamine crystallises out. Methods of utilising the half remaining in solution are described.

ATOMIC WEIGHTS OF SILVER AND CARBON.—The atomic weights of silver and carbon have recently been determined by Dr. G. Dean by the reduction of pure silver cyanide and cyanate in a current of hydrogen (J. Chem. Soc., Dec. 1924). Assuming $O=16$, $Ag=107{\cdot}88$, and $N=14{\cdot}008$, then the ratio $AgCN : Ag$ gave $C=12{\cdot}002\pm0{\cdot}001$. Similarly, the ratio $AgCNO : Ag$ gave $C=12{\cdot}003\pm0{\cdot}001$. By combining these ratios, and assuming only that $O=16$, then $Ag=107{\cdot}871$, and the radical $CN=26{\cdot}008$, which, on subtraction of $14{\cdot}008$, gives $C=12{\cdot}000$.

ELECTROLYSIS OF SOME ORGANIC SALTS.—The electrolysis of salts of some alkyloxyacids is described by D. A. Fairweather in the Proceedings of the Royal Society of Edinburgh (1924, vol. 45, Part I., No. 4). The potassium salts of ethyl ethoxymalonic, ethyl diethoxysuccinic, and ethoxyacetic acids, and sodium amyloxyacetate were used. The chief products are of an aldehydic nature. Hofer and Moest's explanation of the formation of formaldehyde from the electrolysis of sodium glycollate is shown to be applicable to the cases studied; in one case (potassium ethyl ethoxymalonate) the intermediate compound postulated by these investigators was identified in the electrolysis products, owing to its being quite stable.

CARBONISATION TESTS.—The Fuel Research Board has issued a Technical Paper No. 10 on the carbonisation of a South Wales gas coal (Meiros Colliery, Llanharan) in Glover-West continuous vertical retorts. The report gives the results of carbonisation tests resembling in scope and procedure those made on several gas coals from other coalfields. (See F.R.B. Report, 1920–21, and Technical Paper No. 8.) In particular, the effect of steaming was observed and the variation in the results obtained when the percentage of steam was increased from nil to 20 per cent. of the coal treated. The results are fully tabulated and summarised in conjunction with those obtained from other gas coals, which they follow in general lines. The tests form a part of the scheme of the Board to prosecute a survey of the national coal resources, and the compilation and ascertainment of such results will undoubtedly have a value which will be greater as the data available become more complete.

EXPANSION OF ALLOYS.—The eighty-fifth report from the Research Institute for Iron, Steel, and other Metals, Sendai, by Kotaro Honda and Yosikadu Okubo, deals with the measurement of the coefficients of thermal expansion for certain alloys. The apparatus used was the same as that constructed some years ago by Honda. It is a modified form of Chevenard's dilatometer. The entire apparatus can, if necessary, be enclosed in a bell jar which can be evacuated so that the oxidation of metal specimens is avoided. Data are given for certain aluminium alloys, particularly those used in aviation. The results obtained with alloys of iron and nickel are interesting. On adding nickel to iron, the coefficient of expansion decreases slightly up to 18 per cent. of nickel and then increases to 25 per cent. From 25 per cent. it decreases rapidly to 36 per cent. and afterwards increases, rapidly at first, and above 50 per cent. gradually, up to pure nickel. These results coincide with those of Guillaume, the alloy of minimum coefficient of expansion being approximately of the same composition as that of invar. So far as iron-cobalt alloys are concerned, the variations are much smaller. On adding cobalt to iron the coefficient of expansion decreases gradually to a minimum of 48 per cent., and rises gradually to the concentration of pure cobalt.

The Water Supply of Egypt and the Sudan.

IN the report recently issued[1] by the Physical Department of Egypt on the discharges and levels of the Nile and the rains of the Nile Basin for 1919, we have a revival of the reports on the rains of the Nile Basin which, after appearing for eight years, were discontinued on the outbreak of the War.

This report differs from its predecessors in an important respect; the volumes discharged by the Nile and its tributaries now take the first place, and the rainfall measurements form but a minor portion of the volume. This is an indication of the advance which has been made in late years by the Physical Department in the accurate gauging of the Nile supply, a matter of the highest importance both to Egypt and to the Sudan. While formerly most of the determinations were dependent on the accuracy of curves constructed to show the relation between a gauge reading and the corresponding volume of the discharge, we are now presented with no less than 465 measured discharges taken during the year 1919. Of these 210 were on the Blue Nile, 74 on the White Nile, and 138 on the main stream. This gives a precision to the results and an authority to the deductions which may be drawn from them that puts the hydrographic work on the Nile on a very high level.

The discharges have been measured with Gurley's pattern of current meter, and these instruments are rated from time to time at Cairo. It has been suggested that discharges measured during the flood are too large in consequence of the meter being affected by the turbulency of the water, but recent experiments by Mr. B. H. Wade show that this effect has been much overestimated.

The characteristics of the Nile regimen are well brought out in the table; the low stage flow of only 50 cubic metres per second of the Blue Nile in April, and the rapid rise to 8000 cubic metres per second at the beginning of September, in a year when the Abyssinian rainfall was about 30 per cent. below the average, shows how vast a volume of water pours down to the Sudan and Egypt at this season of the year. There is at this time ample water for the needs of the Sudan in the neighbourhood of the Blue Nile when Egypt is receiving more than its land can possibly utilise.

The discharges of the White Nile show a wholly different type of supply; it varied from about 600 cubic metres per second in April and May to 1300 cubic metres per second in October and November, an increase due to water brought in by the Sobat river, which in 1919 received an unusually small supply from the southern plateau of Abyssinia.

There are now 48 river gauges on the Nile and its tributaries south of Wadi Halfa which are read regularly, besides 9 on Lakes Victoria, Kioga, and Albert in Uganda.

The rainfall throughout the Nile Basin is presented in a series of tables, and in most places it was below the normal in 1919. Consequently the level of the lakes on the Lake Plateau of Uganda fell generally; on the Bahrel Jebel the summer rainfall was good, but the extent of marsh in this region prevents the discharge in the lower reaches from gaining by it. The rainfall on the Abyssinian plateau was considerably below the normal, so that the volume passing Wadi Halfa was below the average throughout the year except in July, August, and September; and in November the defect reached 23 per cent.

When we remember that the Nile for the last two thousand miles of its course flows through arid or semi-arid regions, the importance of accurate hydrographical information such as this cannot be overestimated. H. G. L.

[1] Ministry of Public Works, Egypt. Physical Department. "The Discharges and Levels of the Nile and Rains of the Nile Basin in 1919." By P. Phillips. Physical Department Paper No. 11. (Cairo: Government Publications Office, 1924.) P.T.5.

Occurrence and Use of Bitumen.

IN a recent report (No. 625) of the Mines Branch of the Canadian Department of Mines, Mr. Sydney C. Ells contributes a summary account of the nature, mode of occurrence, exploitation, and commercial development of the famous "tar sands" of Northern Alberta, Canada. The report forms an appendix to the author's former "Preliminary Report on the Bituminous Sands of Northern Alberta," No. 281, published in 1914, but for some years out of print. The present summary contains the results of further field-survey of the deposits, including examination and sampling of the sands, a résumé of modern methods of recovery of the bitumen from the sand, and some data concerning the laying of demonstration pavements and roadways.

The principal area of exposure of these sands is along the Athabasca River, outcrops occurring for a distance of more than 220 miles. The deposits are probably of Cretaceous age, though the origin of the bitumen is uncertain, a question which, however, is to form the subject of a report already in preparation. The impregnation varies with the texture of the sand, as would be expected, medium and moderately compact deposits being the richest, finely-graded material being the poorest in bitumen content. Attention is directed to the existence of impervious partings or strata within the deposits which act as horizons of concentration of the bitumen from overlying sands, presumably by downward migration. The more fluid seepages, known as "tar springs," are shown to have originated by lateral migration from slightly inclined beds of particularly rich, coarse-grained sand; the author states that such springs are not of commercial value as sources of bitumen, and further, that it is erroneous to regard them as indications of oil-pools, as has been done by certain geologists who have studied this region. The average bitumen content ranges from 20 per cent. to 25 per cent. in the richest deposits, to 15 per cent. in the normal impregnated sands; the crude bituminous sand has a gravity of 1·75 and a moisture factor of 1·3 per cent.

The commercial application of this material to paving and road construction must be considered as still being in the experimental stage, though results based on eight years of observation on a highway surfaced in three different ways, namely, with sheet asphalt, bitulithic and bituminous concrete, are certainly encouraging, since at the time of writing the author states that "the pavement [*i.e.* road surface] was still in first-class condition, and had required no repairs," notwithstanding that heavy traffic included, apart from motor cars, vehicles carrying loads up to ten tons. Crude bituminous sand is not recommended *per se* as paving material owing to its unbalanced mineral aggregate, lack of uniformity and to freight charges, though it is considered that an attempt should be made to produce an artificial mixture in which the inherent properties and qualities of the sand can be utilised to the greatest advantage. The report concludes with a valuable summary of processes employed for refining bituminous deposits of this character.

University and Educational Intelligence.

LEEDS.—Applications are invited for a lectureship in bacteriology, particulars of which may be obtained from the registrar. The latest date for the receipt of applications is February 23.

LONDON.—On Monday, February 23, Prof. W. T. Gordon will begin a course of twelve Swiney lectures on "The Geological History of Plants," at King's College, at 5.30 o'clock. The succeeding lectures will be given on February 25, March 2, 4, 9, 11, 16, 18, 23, 25, 30, and April 1. Admission will be free.

A free public lecture (in English) on "The Relation of Paralysis Agitans to the Parkinsonian Syndrome of Epidemic Encephalitis" will be given in the Lecture Hall of the Royal Society of Medicine, 1 Wimpole Street, W.1, by Prof. R. Cruchet, of the University of Bordeaux, at 5 o'clock on Wednesday, February 25.

A course of four public lectures on "Puerperal Sepsis" will be given by Prof. B. P. Watson, at St. Thomas's Hospital Medical School on March 2, 3, 4, and 5, at 5 o'clock.

PROF. WIELAND of Königsberg has been offered the chair of pharmacology at the University of Frankfurt.

DR. FRITZ HILDEBRANDT, lecturer at the University of Heidelberg, has been offered the chair of pharmacology at the Medical Academy in Düsseldorf.

DR. PERCY BRIGL, first assistant at the Institute of physiological chemistry in the University of Tübingen, has been nominated professor and director of the Institute of Agricultural Chemistry at the Agricultural Hochschule at Hohenheim.

DR. FRIEDRICH PASCHEN, who was recently appointed president of the Physikalisch-Technische Reichsanstalt, has been elected to an honorary professorship in the philosophical faculty of the University of Berlin.

NOTICE is given that the examinations for the award of the Tate Scholarships in engineering, science, and domestic science at Battersea Polytechnic for the session 1925–1926 will be held on June 9 and succeeding days. The annual value of the scholarships is from 20*l.* to 30*l.* each, with free tuition, and the tenure is three years. The last date of entry is April 18.

A LECTURER in botany at University College, Colombo, will shortly be appointed. Candidates for the post must hold a first-class honours British degree, with botany as the principal subject, or have equivalent qualifications, and should have had experience of lecturing or teaching. Particulars of the appointment and copies of the necessary forms of application are obtainable from the Private Secretary (Appointments), Colonial Office, Downing Street, S.W.1. The completed forms must be returned by at latest March 1.

A JUDICIAL decision of interest to all who are concerned with educational finance was announced in the November number of *School Life*, the official journal of the Washington Bureau of Education. The Supreme Court of Oklahoma upheld the validity of a State appropriation to aid in paying teachers' salaries in districts that had levied the maximum school tax and still could not maintain their schools. The court held that the burden of education rests on the State, and that the local rates are in the nature of aid to the State, which is bound to take such measures as are necessary for financing the school system, so as to afford equality of opportunity throughout the State.

Early Science at Oxford.

February 15, 1683–4. Mr. Aston sent an account of ye ascent of water in a bolt-head, a great while *before* freezing; and that a peice of Ice, of 3¼ inches thick, 4 broad, and a foot long, bore, in ye middle, ye weight of 350 lb, but with 400 lb, after some time, it broke; and (which is most surprising) that ye ice on ye Thames of late was not above 11 inches thick. The same letter told us, that Ice was asserted to be to water in weight, as 7 to 8: which differs not much from Mr. Desmasters late experiment.

Then my Lord Bishop of Ferns his Discourse, concerning Acousticks, and ye severall ways of improving the sense of hearing, was read.

Mr. Ballard acquainted ye company with his success in some late Experiments performed by order of ye company. A part of ye Rosemary stone (lately shewn us by Dr. Plot) after calcination in a charcoale fire, apply'd to a magnet as well as that which had been calcined in a seacoale fire. He chose to calcine it in a charcoale fire, haveing some suspicion it might receive some particles of iron, from ye seacoale; for he has formerly observed seacoal to be a kind of imperfect, or unripe iron-ore, because by an excessive heat of a forge it will flow, like molten metals, and then run to ye bottom of ye fire; where, haveing now lost all its combustible parts, it presently grows dead, and looking black, is cast out, a perfectly burnt cinder.

1686–7.—A letter from Dr. Garden of Aberdeen, Dec. 8, to Dr. Plot, gives an account of ye generation of ye small caterpillar, which infests blossoms of peares and apples, and destroys ye fruit: viz. that they are not bred of mists and dews as Godartius thinks, but of eggs; from whence he draws several other inferences.

February 16, 1685–6.—Mr. Ash, secretary of the Philosophical Society of Dublin, described the case of a woman in ye North of Ireland, who fasted for ye space of eighteen weekes, and did not speak in almost all that time.—This gave Dr. Plot occasion to mention a silent woman now living at Wanborow in Wilts, who has not spoke in near twenty yeares, of whom he promises to procure a more full relation.

February 17, 1684–5.—A Nyctalops, or case of night-blindness, was described by Dr. Briggs. Being a schoolmaster, and able to answer such queries as shall be proposed to him, the Society agreed to send a list of queries, among which were: Whether this Person can see by Candle-light, in a darke room, any time of the Day? Whether, at any time, by candle-light darted through a Ball of water? Whether by ye light of Glow-wormes, rotten wood, Herrings heads &c.? Whether at any time, and by any light, with ye Bishop of Ferns his Spectacles? Whether his Eyes are equally affected?

A description of the Cicindela volans, by Mr. Waller, F.R.S. was read, and Dr. Plot affirm'd, that this Insect has been observed in Staffordshire.

Mr. Walker brought in an account of the prices of ye best wheat and mault at Oxford on the market-dayes next before Lady-day and Michaelmas for twenty yeares last past: by which it appeares, that the price of wheat for twenty yeares last past at a mean rate (*i.e.* one year with another) has been 5*s.* 4¼*d.* ye bushell: mault, during the same time, in ye same market, at a mean rate, has sold at 2*s.* 11½*d.* ye bushell.

Mr. Cole promised patterns of Dyes of seven distinct colours from his Shell-fish, viz.: white, a fine yellowish green, a fair deep sea-green, a deep Watchet blew, a sullen purple, a deep dark sanguine, and ye bright Tyrian purple.

Societies and Academies.

LONDON.

Royal Society, February 5.—H. M. **Carleton**: Growth, phagocytosis and other phenomena in tissue cultures of fœtal and adult lung. Invasion of the medium in a growing culture is the result of:—(1) Sheet-like epithelial outgrowth from the alveolar epithelium of cut alveoli. (2) Radiating growth of fibroblasts from the connective tissue of the lung. (3) "Membrane-formation," in which the cells of the cicatricial epithelium detach themselves from the implant. Within the implant there occurs a swelling up, and a detachment of, the alveolar epithelial cells. Mitoses are frequent in these—even in cultures of adult lung. Sterile coal or carmine particles are actively phagocytosed by both fœtal and adult lung *in vitro*. The alveolar epithelial cells are actively phagocytic, the dedifferentiated cells of the cicatricial epithelium less so.—F. W. **Fox** and J. A. **Gardner**: The origin and destiny of cholesterol in the animal organism. Part XIV.—The cholesterol metabolism in normal breast-fed infants. During the first week of life there is a daily average negative balance of 0·14 gram. This is to a large extent accounted for by the fact that the meconium is being got rid of. During the second and third week of life the average intake and output in the cases examined practically balance. At this stage the composition of the milk is in a transitional state from colostrum to true milk. In the last group of infants, from the seventh week to tenth month, there is an excess of intake over output, and the average positive balance is 0·069 gram per day. There must be some organ in the body capable of synthesising cholesterol, but the sterol present in the diet of infants is a source of supply which cannot be disregarded.—H. H. **Thomas**: The Caytoniales, a new group of angiospermous plants from the Jurassic rocks of Yorkshire. The fossils are the remains of megasporophylls with carpels, fruits, and seeds of two distinct types, and male inflorescences bearing stamens. They were found in the Gristhorpe Plant Bed in the Middle Estuarine Series, exposed on the Yorkshire coast in Cayton and Gristhorpe Bays. The species *Gristhorpia Nathorsti* gen. et sp. nov. had pinnate megasporophylls 4-5 cm. long, with an axis about 1 mm. wide; the sub-opposite pinnæ terminate in small more or less spherical carpels 2-5 mm. in diameter. The carpels have a stigma at the base near the pedicel. Winged pollen-grains were found on some of the stigmas. The seeds had a well-developed megaspore membrane with an apical projection, above which was a micropyle lined with cutinised cells. *Caytonia Sewardi* possessed megasporophylls agreeing generally with those of Gristhorpia, but the stigma was a small basal flange. The carpels and fruits contained two rows of ovules or seeds, with hard woody or stony testas. The remains of the male inflorescences are of a type previously known as *Antholithus* sp. and now named *Antholithus Arberi*. They were probably borne on the same plants as *Gristhorpia Nathorsti*. The anthers were four-lobed sessile structures, of a form very like that found in many modern Angiosperms, and had a longitudinal dehiscence. There are no traces of perianth members or bracts. There is a constant association of megasporophylls and fruits with leaves of *Sagenopteris Phillipsi* (Brongn.). The comparative examination of the cuticular structure of the axes of Gristhorpia and Caytonia and of the petioles of Sagenopteris fronds, makes it probable that Sagenopteris must be regarded as the leaf of the Caytoniales.—Winifred **Brenchley** and H. G. **Thornton**: The relation between the development, structure and functioning of the nodules on *Vicia Faba* as influenced by the presence or absence of boron in the nutrient medium. In the absence of boron the vascular supply of the nodule is defective. The strands are often entirely absent, or weakly developed. In plants grown without boron the number of nodules that attain macroscopic size is much reduced. In the nodules without vascular strands, the bacteria do not swell out to form the so-called "bacteroids." When weakly developed strands enter the nodule, the amount of tissue containing bacteroids is closely correlated with the extent of the strands. In the plants bearing these abnormal nodules very little nitrogen is fixed, the quantity fixed per nodule being, in one experiment, less than one-tenth of that fixed in normal plants. In the absence or weak development of vascular strands in the nodule, the bacteria tend to become parasitic. This change in relations between micro-organism and host is connected with loss or reduced supply of carbohydrate energy material normally brought into the nodule by the vascular strands.—A. S. **Rau**, F. W. R. **Brambell** and J. B. **Gatenby**: Observations on the Golgi bodies in the living cell. The so-called "nebenkern" of molluscan germ-cells is the Golgi apparatus, and it can be shown *intra vitam* by Janus green and neutral red. It is visible in fresh cells *intra vitam*, and can be photographed. It stains heavily in the Lewis Janus green-iodine vapour method. The Golgi rods or batonettes are rigid bodies, which retain their shape when released from the cell. Neither the Lewis Janus green-iodine vapour method nor Janus green alone are specific for the mitochondria.—V. **Nath**: Cell inclusions in the oogenesis of scorpions. In forms the oocytes of which contain vitelline yolk there is copious discharge of nucleolar material preceding yolk formation. In other forms the nucleolus remains quite inactive. The Golgi elements in Palamnæus swell up enormously after fragmentation and give rise to yolk (Golgi yolk), which contains free fat like the Golgi yolk of Lithobius (Nath) and *Helix aspersa* (Brambell). The Golgi elements of Euscorpius and Buthus also swell up and form Golgi yolk which, however, retains the same chemical constitution as the Golgi elements. In the centrifuged oocytes of Euscorpius the vitelline yolk is thrown down and the Golgi yolk tends to go towards the opposite pole. The central area is occupied by the granular mitochondria, the unchanged Golgi elements and the nucleus. The mitochondria in all the forms studied are granular and do not take any part in vitellogenesis. Although there is a remarkable disparity, paralleled only in *Paludina vivipara*, in size of the granular mitachondria of oocytes, on one hand, and the very prominent, hollow, vesicular mitochondria of spermatocytes on the other, the vesicular type is only a phase in spermatogenesis.—L. J. **Harris**: The combination of proteins, amino-acids, etc., with acids and alkalis and their combining weights, as determined by physico-chemical measurements.

Physical Society, January 23.—W. **Clack**: An investigation into corrections involved in the measurement of small differences in refractive index of dispersive media by means of the Rayleigh interferometer, with special reference to the application of the results to measurements in diffusion.—B. J. **Taylor** and W. **Clarkson**: A study of the production of "flashing" in air electric discharge tubes. The volt-ampere characteristics for the air discharge tubes is of the general form, $i=k(V-M)$. As in the case of the

"osglim" lamp, there is a critical resistance R_c below which no "flashing" is possible, given by $R_c = E - V_B/\{k(V_B - V_A)\}$. — C. R. **Darling**: A kinematographic study of the formation of Plateau's spherule. Orthotoluidine is allowed to flow slowly into the bulb of an inverted thistle funnel supported mouth downwards in water; when a sufficient body of the liquid has collected, a large drop is formed which gradually changes shape until it breaks away, leaving behind a small secondary droplet known as "Plateau's spherule." Kinematographic study of the breaking process shows that the main drop remains approximately spherical, the liquid to which it is attached extending downwards in a sharply pointed cone attached to the main drop at its point. After breaking away, the main drop falls, oscillating considerably in shape. The rest of the liquid snaps back to form a more or less spherical surface, but the point of the cone is left behind to form the droplet referred to; this is given a slight upward impulse before it also falls to the bottom of the water.

PARIS.

Academy of Sciences, December 29.—Ch. **Lallemand**: Concerning the tetrahedral system. Lowthian Green in 1875 suggested that a hollow sphere, submitted to an external pressure, should take a form derived from the tetrahedron. In a recent note Lecornu shows that this view is not supported by a mathematical investigation. Experiments by the author, in 1887, on rubber balloons, and by Ghesquière and de Joly, in 1895, on glass globes softened by heat, are in accord with the tetrahedral theory.—Marcel **Brillouin**: The equations of state of the plastic phase of a solid naturally isotropic.—Gabriel **Bertrand** and M. **Mokragnatz**: The general presence of nickel and cobalt in arable earth. In an earlier communication, the presence of traces of nickel and cobalt in two samples of soil was proved. The analytical method has now been improved, and results of analyses of thirty-three soils from different localities (France, Germany, Denmark, Italy, Roumania) are given. The amounts found, expressed in parts per million of earth, vary between 38·6 and 4·7 for nickel and 11·7 and 0·3 for cobalt. There is always less cobalt than nickel. Dust from interplanetary space is suggested as a possible source of these two metals in arable earth.—André **Blondel**: Certain coefficients of self-induction of alternators.—V. **Grignard** and J. **Savard**: The enolic form of pulegone.—C. **Sauvageau**: Some examples of *hétéroblastie* in the development of some Algæ (Castagnea). — R. H. **Germay**. — The integration by successive approximations of systems of partial differential equations of the first order.—Fritz **Carlson**: Integral functions.—S. **Stoilow**: An ensemble where a continued function has a constant value.—Antoine **Lomnicki**: Some generalisations of the arithmetical triangle of Pascal.—L. **Escande** and M. **Ricaud**: Some methods of measuring velocities in hydraulics. The chronophotographic method of measuring velocities, utilising fine powder in suspension, fails when the fluid is in a turbulent state. The substitution of small spheres of density equal to that of the water for the powder gives good results for the mean local velocity. The conditions under which the Pitot tube gives trustworthy measurements are discussed, and a modified method suitable for low velocities described.— —**Rateau**: Remarks on the preceding communication.—A. de **Gramont de Guiche**: An acoustic indicator of relative velocity for an aeroplane.—R. **Biquard** and A. **Chenu**: A method for the regeneration of the gas of a balloon, avoiding deflation.—J. **Guillaume**: Observations of the sun, made at the Observatory of Lyons during the third quarter of 1924. Observations of the number of spots, their distribution in latitude, and the distribution of the faculæ in latitude were made on 87 days during the quarter.—A. P. **Rollet**: An electrolytic frequency meter of simple construction. The apparatus is based on the phenomena of successive oxidation and reduction shown by a silver electrode, when the electrolysis takes place in an alkaline solution with a low frequency alternating current.—Albert **Nodon**: Researches on X-rays of long wavelength.—J. H. **Shaxby**: The production of Laue diagrams by means of monochromatic X-rays, and the structure of mother-of-pearl. The mineral part of mother-of-pearl consists of crystals of aragonite, the quasi-hexagonal axis of which is normal to the leaflets.—F. **Croze**: The structure of the line spectrum of nitrogen.— —**Lespieau**: The preparation of true acetylene compounds, starting with the mixed magnesium derivatives of acetylene.—H. **Colin** and Mlle. A. **Chaudun**: The hydrolysis constant of sugar. The authors qualitatively confirm the results of Moran and Lewis, and find that the velocity of hydrolysis increases more rapidly than the concentration of the sugar, although quantitatively there is not exact agreement. This increase in the velocity of hydrolysis with sugar concentration is shown to depend on the nature of the acid employed as the catalyst.— —**Royer**: The orientation of the crystals of ammonium iodide by muscovite.—G. **Mouret**: The structure of the granitic region of Millevache.—Maurice **Collignon**: The audition of explosion waves at great distances. Deductions from the explosion experiments at Courtine in May 1924.—M. **Coyecque** and Ph. **Wehrlé**: The formations of Hatteras.—Paul **Guérin**: The development of the anther and pollen in gentians.—L. **Léger**: The nutritive value of the snail (*Helix pomatia*). In *Helix pomatia*, in the condition of winter sleep, upwards of 80 per cent. of the fat, and all the glycogen and reducing sugars, are localised in the part usually rejected for food. The snail should be eaten *in toto*.—Alexandre **Lipschütz**: An intersexual malformation in the guinea-pig.—Léon **Blum**, Maurice **Delaville**, and van **Caulaert**: Contribution to the study of the pathogeny of rickets. The essential trouble in rickets is not due to an alteration of the mineral contents of the blood, but in modifications of their physico-chemical state, the latter resulting from an alteration of the acid-base equilibrium.—Marcel **Duval**: The ionic reaction of the blood of some invertebrates.— —**Cluzet, Rochaix** and **Kofman**: Variations in the agglutinating power of sera under the influence of the continuous electrical current.—Maurice **Nicloux**: New demonstrations of the normal presence of carbon monoxide in the blood. The presence of traces of carbon monoxide in normal blood has been disputed: from the results of experiments described by the author, the presence of this gas in normal blood is proved.—A. **Malaquin**: The genital glands and primordial sexual cells in the annelid *Salmacina Dysteri*.—Mlle. **Goldsmith**: Light and the symbiotic relations in *Convoluta roscoffensis*.—Constantin **Gorini**: The mammary coccus.—A. **Borrel** and Mlle. **Muller**: Vaccinal virus in the cornea of the rabbit.

January 5.—L. **Lecornu**: The tetrahedral deformation. Remarks on the experiments of M. Lallemand.—W. **Kilian** and G. **Sayn**: The external edge of the subalpine chains to the east of Valence (Drôme) and the breccia of Pialoux.—Paul **Vuillemin**: The *Nématés*, a new division of the animal kingdom.—Jean **Effront**: The absorbing power of agar-agar. Extraction with acid reduces the mineral content of agar-agar, and this demineralised agar does not absorb acid. Pulps from plants, such as beetroot and potato, behave in a similar manner.— — **Angelesco**: Certain systems of

biorthogonal functions.—A. **Bloch**: On a circle where a holomorph function takes at least twice the values 0 and 1.—S. **Saks**: A class of interval functions.—J. **Haag**: The experimental determination of the parameter of precision.—A. **Talon**: The piezometric equivalence of the yield of transmission.—W. W. **Heinrich**: New classes of secular solutions of the problem of n bodies.—L. **d'Azambuja**: Observations of mobile masses of absorbing vapour at great heights above the solar surface. Comparison with high protuberances of rapid evolution.—Albert **Pérard**: The refractive index of air, in the visible spectrum, between 0° and 100° C. The apparatus used was that of Benoit, slightly modified. The final result is given by the equation

$$(N-1)10^6 = \left(288{\cdot}02+\frac{1{\cdot}482}{\lambda^2}+\frac{0{\cdot}0309}{\lambda^4}\right)\left(\frac{h}{760}\right)\left(\frac{1}{1+0{\cdot}003716\,\theta}\right),$$

where λ is the wave-length in microns, θ the temperature in centigrade degrees.—Y. **Rocard**: The diffusion of light in fluids.—Mlle. M. **Hanot**: The width of the lines of the Balmer series in the oscillating discharge. For a given initial temperature and pressure, the maximum intensity of the current which traverses a slightly damped oscillating spark determines the width of the lines studied.——**Bayen**: The spark spectra of tungsten and mercury in the extreme ultra-violet.—R. **Jouaust** and P. **Waguet**: The use of the photo-electric cell for certain measurements in industrial photometry. In photometric measurements it is not, in general, possible to replace eye observations by a photo-electric cell, but in certain cases it is possible. One possible application of the cell is the preparation of standard electric lamps, and a description of the method used and precautions necessary is given.—J. **Valentin** and G. **Chaudron**: The solidification of the ternary alloys of aluminium, magnesium, and cadmium.—Édouard **Urbain**: The absorption of vapours by carbon. Defining the "compacity" of carbon as the ratio of the true volume to the apparent volume, absorption curves are given showing the amount of vapours of chlorine, chloropicrin, and benzene absorbed as a function of the compacity. In the case of benzene there is a maximum absorption for compacity 0·3.—Pierre **Auger**: The secondary β-rays produced in a gas by X-rays.—L. **Hackspill** and R. **Grandadam**: The displacement of the alkali metals by iron. At a moderately high temperature, in a vacuum, iron sets free the metals of the alkalies from their hydroxides; in some cases it is possible to collect the alkali metal; in others the presence of the metal can only be proved by the evolution of hydrogen in contact with steam.—Al. **Orékhoff** and Max. **Roger**: The semipinacolic deamination of some amino-alcohols. Amino-alcohols of the type $R.R'.C(OH).CH_2(NH_2)$, treated with nitrous acid, give the ketones $R.CO.CH_2.R'$.—Max and Michel **Polonovski**: Oxyeserine and its derivatives.—Marcel **Sommelet**: Researches in the diphenylmethene series Trimethylbenzhydryl-ammonium bromide.—J. **Grosjean** and M. **Dosios**: The horizon of the Posidonomyes schists containing hydrocarbons of the Toarcian of the Franche-Comté Jura. Analyses of four schists are given, showing yields of oil. Separate analyses of the oils are appended.—E. G. **Mariolopoulos**: The rains sometimes observed with anticyclones.—René **Fabre**: The nature and variations of the aldehyde contained in the blood. There exists in the blood a volatile reducing substance possessing the characters of acetaldehyde.—G. **Mouriquand**, A. **Leulier** and P. **Michel**: Fluctuations of the iron in blood in the course of experimental scurvy.

Official Publications Received.

Anales del Museo Nacional de Historia Natural de Buenos Aires. Tome 31. Pp. iv+678. (Buenos Aires.)

The Journal of the Institute of Metals. Vol. 32. Edited by G. Shaw Scott. Pp. xii+820+37 plates. (London: 36 Victoria Street, S.W.1.) 31*s.* 6*d.* net.

University of California Publications in American Archæology and Ethnology. Vol. 21, No. 3: The Uhle Pottery Collections from Ica. By A. L. Kroeber and William Duncan Strong. With three Appendices by Max Uhle. Pp. 95-133+plates 25-40. (Berkeley: University of California Press.) 85 cents.

Crichton Royal Institution, Dumfries. Eighty-fifth Annual Report, for the Year 1924. Pp. 45. (Dumfries.)

Union of South Africa. Department of Agriculture (Division of Chemistry Series No. 51). Science Bulletin No. 35: Profitable Potato Production; Results of a Bethal Co-operative Experiment. By Thos. D. Hall. Pp. 14. (Pretoria: Government Printing and Stationery Office.)

Annals of the Natal Museum. Edited by Dr. Ernest Warren. Vol. 5, Part 2, January. Pp. 101-234+plates 8-14. (London: Adlard and Son and West Newman, Ltd.) 15*s.* net.

Proceedings of the American Academy of Arts and Sciences. Vol. 59, No. 16, December: The Bodily Proportions of Women in the United States; based upon Measurements taken from one hundred Smith College Students. By Dr. Harris Hawthorne Wilder and Margaret Washington Pfeiffer. Pp. 439-603. (Boston, Mass.) 4.25 dollars.

The Journal of the Royal Horticultural Society. Edited by F. J. Chittenden. Vol. 50, Part 1, January. Pp. 172+lxxvii. (London: Vincent Square, S.W.1.) 7*s.* 6*d.*

Royal Horticultural Society. Notices and Arrangements for the Year 1925; Report for the Year 1924, with Statement of Accounts; List of new Fellows; Horticultural Advertisements. Pp. 167+lxxvii. (London: Vincent Square, S.W.1.)

Carnegie Institution of Washington. Annual Report of the Director of the Department of Terrestrial Magnetism. (Extracted from Year Book No. 23, for the Year 1924.) Pp. 145-186. (Washington.)

Proceedings of the Edinburgh Mathematical Society. Edited by Dr. Archibald Milne and Dr. T. M. Macrobert. Vol. 42 (session 1923-24), Part 2. Pp. 61-112+viii. (London: G. Bell and Sons, Ltd.)

Annals of the (Mededelingen van het) Transvaal Museum. Vol. 11, Part 1: The Sphegidæ of South Africa. By Dr. George Arnold. Part 5: On Cynodontia from the Middle Beaufort Beds of Harrismith, Orange Free State; On a new Type of Thecodont from the Middle Beaufort Beds. By Dr. S. H. Haughton. Pp. 97+8 plates. (Cambridge: Printed at the University Press.)

Armstrong College, Newcastle-on-Tyne. Standing Committee for Research: First Annual Report, 1923-4. Pp. 12. (Newcastle-on-Tyne.)

Proceedings of the Society for Psychical Research. Part 92, Vol. 34, December. Pp. 201-341. (London: Francis Edwards.) 9*s.* net.

Diary of Societies.

SATURDAY, FEBRUARY 14.

ROYAL INSTITUTION, at 3.—W. Rothenstein: The Artist's Relation to Social and Religious Life (I.).

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 4.—Sir D'Arcy Power: Hunterian Oration.

INSTITUTION OF STRUCTURAL ENGINEERS (Western Counties Branch) (at Royal Institution, Swansea), at 6.—G. B. R. Pimm: Piles and Pile Foundations.

INSTITUTE OF BRITISH FOUNDRYMEN (Lancashire Branch, Junior Section) (at Municipal College of Technology, Manchester), at 7.—W. H. Meadowcroft: Some Foundry Experiences.

INSTITUTION OF AUTOMOBILE ENGINEERS (at Loughborough Technical College), at 7.30.—Loughborough Graduates' Meeting.

INSTITUTE OF METALS (London Local Section) (at Institute of Marine Engineers), at 7.30.—V. C. Faulkner: Some Notes on Refractory Materials.

MONDAY, FEBRUARY 16.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—C. P. G. Wakeley: The Etiology, Pathology, and Treatment of Ectopic and Imperfect Descent of the Testis.

ROYAL SOCIETY OF MEDICINE, at 5.30.—Dr. L. Williams, Col. R. McCarrison, Dr. W. Cramer, Dr. G. M. Findlay, and others: Special Discussion on Non-Specific Disturbances of Health due to Vitamin Deficiency.

INSTITUTION OF AUTOMOBILE ENGINEERS (Birmingham Centre) (at Chamber of Commerce, Birmingham), at 7.—F. G. Woollard: British Methods of Continuous Production.

JUNIOR INSTITUTION OF ENGINEERS (North-Western Section) (at 16 St. Mary's Parsonage, Manchester), at 7.15.—A. D. Young: The Design and Construction of the No. 5 Gas Holder for Burnley Corporation.

INSTITUTION OF AUTOMOBILE ENGINEERS (Scotland Centre) (at Royal Technical College, Glasgow), at 7.30.—C. H. Macmillan: Marine Motor Installation.

BRITISH ASSOCIATION OF CHEMISTS (Birmingham Section) (in Medical Theatre, Birmingham University), at 7.45.—Dr. F. W. Aston: Atomic Weights and Isotopes.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—D. S. McColl: Sculpture in relation to Architecture.

ARISTOTELIAN SOCIETY (at University of London Club), at 8.—Dr. J. Drever: The Meaning of Consciousness for the Psychologist.

ROYAL SOCIETY OF ARTS, at 8.—Dr. W. Rosenhain: The Inner Structure of Alloys (Cantor Lectures) (I.).

FARADAY SOCIETY (at Chemical Society), at 8.—Prof. A. J. Allmand and V. S. Puri: The Effect of Superposed Alternating Current on the Anodic Solution of Gold in Hydrochloric Acid.—Prof. C. H. Desch and

Eileen Vellan: The Electrolytic Deposition of Cadmium and other Metals on Aluminium.—W. M. Thornton and J. A. Harle: The Electrolytic Corrosion on Ferrous Metals.—S. Glasstone: Overvoltage and Surface Forces at the Lead Cathode.—M. Shikata: The Electrolysis of Nitrobenzene with the Mercury-dropping Cathode.—J. R. Coutts: The Law of Distribution of Particles in Colloidal Suspensions: A Note on the Specific Volume of a Gamboge Suspension.—W. W. Barkas: The Distribution of Particles in Colloidal Suspensions.

CAMBRIDGE PHILOSOPHICAL SOCIETY (in Botany School, Cambridge), at 8.45.—Prof. D. M. S. Watson: Orthogenesis.

MEDICAL SOCIETY OF LONDON, at 9.—Sir Bernard Spilsbury: Wounds and other Injuries (Lettsomian Lectures) (I.).

CHEMICAL INDUSTRY CLUB (at 2 Whitehall Court).

TUESDAY, FEBRUARY 17.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. J. Barcroft: The Colour of the Animal Creation (II.). The Colour of the Hare.

ROYAL STATISTICAL SOCIETY (at Royal Society of Arts), at 5.15.—E. J. Russell and T. Edser: The Fishery Statistics of England and Wales.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—Secretary: Report on the Additions made to the Society's Menagerie during the month of January 1925.—Major S. S. Flower: Contributions to our Knowledge of the Duration of Life in Vertebrate Animals.—I. Fishes; II. Batrachians.—R. I. Pocock: (*a*) The External Characters of an American Badger (*Taxidea taxus*) and an American Mink (*Mustela vison*) recently exhibited in the Society's Gardens; (*b*) Additional Notes on the External Characters of some Platyrhine Monkeys.—Dr. R. Broom: The Origin of Lizards.—A. Loveridge: *Natrix olivacea* Peters (Reptilia), from Pemba Island, and other Notes.—E. P. Allis, jun.: The Origin of the V-shaped Branchial Arch in the Teleostomi.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Western Centre) (at Engineers' Club, Manchester), at 7.—H. W. Clothier: The Design of Electrical Plant, Control Gear, and Connexions for Protection against Shock, Fire, and Faults.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Kinematograph Group), at 7.—C. F. Elwell: The De Forest Phonofilms.

INSTITUTE OF CHEMISTRY AND SOCIETY OF CHEMICAL INDUSTRY (at 36 York Place, Edinburgh), at 7.30.—T. Bolam, W. O. Kermack, W. T. H. Williamson, and others: Discussion on The Stability of Colloids.

INSTITUTION OF ELECTRICAL ENGINEERS (Scottish Centre) (at Freemasons' Hall, Edinburgh), at 7.45.—Prof. G. W. O. Howe: World-wide Radio Telegraphy (Faraday Lecture).

HULL CHEMICAL AND ENGINEERING SOCIETY (at Grey Street, Hull), at 7.45.—R. A. Bellwood: The Romance of the Vegetable Oils.

WEDNESDAY, FEBRUARY 18.

SOCIETY OF GLASS TECHNOLOGY (at Sheffield), at 2.30.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Dr. G. Scott Williamson: The Anatomy and Physiology of the Thyroid Apparatus (I.).

SOCIETY OF CHEMICAL INDUSTRY (Liverpool Section) (jointly with the Liverpool Geological Society) (in Chemistry Department, Liverpool University), at 6.—Prof. P. G. H. Boswell: Mineral Oil: Supplies of the Present and Future.

INSTITUTION OF CIVIL ENGINEERS (Students' Meeting), at 6.—R. H. Tangri: Reconstruction of Barrow Haven Bridge, Lincolnshire, L. and N.E. Ry.

INSTITUTION OF ELECTRICAL ENGINEERS (South Midland Centre) (at Birmingham University), at 7.—H. W. Clothier: The Design of Electrical Plant, Control Gear, and Connexions for Protection against Shock, Fire, and Faults.

INSTITUTION OF AUTOMOBILE ENGINEERS (Birmingham Graduates' Meeting) (at Chamber of Commerce, Birmingham), at 7.30.

SOCIETY OF CHEMICAL INDUSTRY (Newcastle Section) (at Armstrong College), at 7.30.—Prof. H. V. A. Briscoe and P. L. Robinson: A Redetermination of the Atomic Weight of Boron.

INSTITUTION OF ELECTRICAL ENGINEERS (Sheffield Sub-Centre) (at Royal Victoria Hotel, Sheffield), at 7.30.—W. B. Woodhouse: Presidential Address.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—Miss L. Doris Sawyer: The Effect of Pressure Distribution upon London's Sunshine in Winter.—Prof. S. Chapman: On the Changes of Temperature in the Lower Atmosphere, by Eddy Conduction and otherwise.—N. K. Johnson and O. F. T. Roberts: The Measurement of the Lapse Rate by an Optical Method.

ROYAL SOCIETY OF ARTS, at 8.—Dr. J. S. Owens: Modern Atmospheric Conditions.

IPSWICH AND DISTRICT NATURAL HISTORY SOCIETY.—J. M. Hill: Primitive Medicine and Folk-lore of the Guiana Indians.

THURSDAY, FEBRUARY 19.

MEDICO-PSYCHOLOGICAL ASSOCIATION (at Royal College of Physicians, Edinburgh), at 2.30.—Dr. D. Slight: The Psycho-galvanic Reaction.—Dr. G. Gibson: The Boarding-out System.—Dr. W. M. McAlister: Results of Treatment of General Paralysis by Malaria.

ROYAL SOCIETY, at 4.30.—Prof. O. W. Richardson and A. F. A. Young: The Thermionic Work-Functions and Photoelectric Thresholds of the Alkali Metals.—J. H. Brinkworth: The Measurement of the Ratio of the Specific Heats using Small Volumes of Gas.—F. H. Constable: The Catalytic Action of Copper. Parts VI. and VII.—V. H. Stott, Edith Irvine, and D. Turner: Viscosity Measurements of Glass.—*To be read in title only*:—W. G. Palmer and F. H. Constable: The Catalytic Action of Copper. Part V.—P. A. M. Dirac: The Adiabatic Invariance of the Quantum Integrals.—D. L. Watson: The Thermal Decomposition of Derivatives of Oxalacetic Ester—A Unimolecular Reaction.—K. R. Rao: (1) The Fluorescence and Channelled Absorption of Bismuth at High Temperatures; (2) A Note on the Absorption of the Green Line of Thallium Vapour.

LINNEAN SOCIETY OF LONDON, at 5.—Miss A. Lorrain Smith: John Templeton's Drawings of Lichens and Fungi.—Dr. J. Burtt-Davy: The Tropical African Element in the Arborescent Flora of the Transvaal.—Prof. R. R. Gates: Virescent Inflorescence of Delphinium.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Sir William Bragg: The Properties and Structure of Quartz (IV.).

INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—F. M. Alexander: An Unrecognised Principle in Human Behaviour.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—Major E. I. David: Electricity in Mines.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 7.—Lt.-Col. L. F. R. Fell: Light Aeroplane Engine Developments.

INSTITUTION OF ELECTRICAL ENGINEERS (Mersey and North Wales (Liverpool) Centre) (at Liverpool University), at 7.—W. E. Bush: Modern Electric Lighting Practice.

INSTITUTION OF AUTOMOBILE ENGINEERS (Derby Graduates' Meeting) (at Cavendish Café, Derby), at 7.30.—R. Bolton: The Early History of Road Transport.

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE, at 7.45.—Dr. H. Meleney: Demonstration on the Pathology of Experimental Leishmaniasis in the Hampster.—At 8.15.—Prof. B. Blacklock: Schistosomiasis and Goitre in Sierra Leone.

CHEMICAL SOCIETY, at 8.

SOCIETY OF DYERS AND COLOURISTS (West Riding Section).—Prof. E. C. C. Baly: Photosynthesis of Naturally Occurring Compounds.

FRIDAY, FEBRUARY 20.

GEOLOGICAL SOCIETY OF LONDON, at 3.—Annual General Meeting.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Dr. G. Scott Williamson: The Anatomy and Physiology of the Thyroid Apparatus (II.).

SOCIETY OF CHEMICAL INDUSTRY (Liverpool Section) (at Liverpool University), at 6.—Discussion.

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

INSTITUTION OF ELECTRICAL ENGINEERS (South Midland Centre) (at City Council Chamber, Birmingham), at 7.—W. B. Woodhouse: Presidential Address.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group), at 7.—A. C. Banfield: Photography by Artificial Light.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—J. N. Seddon: Inverted Tooth Chain Drives.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. T. H. Pear: Acquiring Muscular Skill.

SOCIETY OF DYERS AND COLOURISTS (Manchester Section) (at 36 George Street, Manchester).—D. A. Glibbens: Some Work done in the Chemical Department of the Shirley Institute.

INSTITUTION OF ENGINEERING INSPECTORS.—Major C. E. S. Phillips: The Radium Industry.

SATURDAY, FEBRUARY 21.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—W. Rothenstein: The Artist's Relation to Social and Religious Life (II.).

PHYSIOLOGICAL SOCIETY (at London School of Medicine for Women).

PUBLIC LECTURES.

SATURDAY, FEBRUARY 14.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—E. Lovett: Natural History in Folk-lore.

MONDAY, FEBRUARY 16.

ST. BARTHOLOMEW'S HOSPITAL MEDICAL COLLEGE, at 5.—Sir William I. de Courcy Wheeler: Some Practical Considerations and Experiences in the Conservative Treatment of Fractures of the Pelvis and the Lower Extremity (I.). (Succeeding Lectures on February 17, 18, 19.)

LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE, at 5.—Dr. E. B. Behrens: Organising an International Civil Service for Purposes of Industrial Research.

UNIVERSITY OF LEEDS, at 5.15.—Dr. H. H. Dale: Anaphylaxis.

MEDICAL SOCIETY OF LONDON, at 5.15.—Prof. E. W. Hope: International Hygiene (Chadwick Lecture).

BIRKBECK COLLEGE, at 5.30.—Dr. G. G. Coulton: Medieval Education (III.). Spoken Latin in the Middle Ages.

KING'S COLLEGE, at 5.30.—Prof. A. E. Jolliffe: English Mathematics before Newton.

TUESDAY, FEBRUARY 17.

KING'S COLLEGE, at 5.30.—Miss Evelyn Underhill: The Realism of the Mystics.

UNIVERSITY COLLEGE, at 5.30.—Prof. J. E. G. de Montmorency: The Significance of the Humanism of the Negro Races.

GRESHAM COLLEGE, at 6.—Sir H. Walford Davies: Music. (Succeeding Lectures on February 18, 19, 20.)

UNIVERSITY OF LEEDS, at 8.—Prof. J. H. Priestley: Moorland Plants.

WEDNESDAY, FEBRUARY 18.

LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE, at 5.—J. Thorp: The Principles of Design as applied to Books and Printing.

KING'S COLLEGE, at 5.30.—Baron A. F. Meyendorff: Travels in the East. A.D. 800–1200.

UNIVERSITY COLLEGE, at 5.30.—A. Gomme: Technical and Scientific Libraries.

THURSDAY, FEBRUARY 19.

KING'S COLLEGE, at 5.30.—Dr. I. P. Bruce: Education in China.

CENTRAL LIBRARY, 598 Fulham Road, at 8.—A. J. Linford: England's Story in Stone.

SATURDAY, FEBRUARY 21.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—F. Balfour Browne: My Journey to Brazil.