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INTERDEPARTMENTAL CO-OPERATION IN RESEARCH

AN account of what is being done in America in the broad field of experimental human biology to promote co-operative research has been given in a recent paper on "General Aspects of Interdisciplinary Research in Experimental Human Biology" by Dr. Josef Brozek and Prof. Ancel Keys, of the University of Minnesota (*Science*, **100**, 507 ; 1944). This paper, apart from its specialized interest, is of wide importance in that it indicates some of the fundamental problems of the most effective organization of research effort everywhere, and it is a valuable contribution to constructive thought on the unity of knowledge. It will be recalled that the Manchester Literary and Philosophical Society recently devoted a meeting to this subject, and to the means of redressing that progressive disintegration which, as Prof. T. W. Manson emphasized, is such a characteristic feature of our civilization.

Dr. Brozek and Prof. Keys direct attention to some of the implications of the attempt to develop in the academic field the co-operative attack on problems by whole groups of specialists such as physicists, biochemists, bacteriologists, nutritionists, pathologists, physiologists, histologists, and psychologists. At present, competition between university departments may create a barrier to interdepartmental work. Again, it is pointed out by Dr. M. A. May, director of the Yale Institute of Human Relations, that the departmental method tends to encourage individualism and to discourage the ambitious worker from participating in interdepartmental collaborative projects. A third barrier is formed by traditional attitudes and ideas, such as the belief that scientific discoveries are always the products of individual minds, or that the co-operative setting limits the freedom of the scientific worker to follow the dictates of his own intellectual curiosity. A fourth barrier results from university training in habits of individual work.

As a result, Dr. Brozek and Prof. Keys point out, the young scientific worker is poorly prepared to participate in the activities of a committee or a research team. He may have become skilful in gathering empirical data within his own narrow field, but his techniques of social interaction are undeveloped and ineffective in practice. The Yale Institute of Human Relations was created more than a decade ago to meet this need for bridging several anthropological disciplines. The purpose was to correlate knowledge and co-ordinate technique in related fields, so that greater progress may be made in the understanding of human life from the biological, psychological and sociological points of view. Since 1930 other university institutes have been organized on inter-disciplinary lines, and Dr. Brozek and Prof. Keys strongly urge that such developments should form a part of graduate schools and not be left to industrial organizations, which will rarely provide the time and personnel to carry out a training programme of high scientific standing.

There can be little doubt that Dr. Brozek and Prof. Keys are on firm ground in urging that more should be done to break down departmentalism and encourage the attack on fundamental problems by workers in different branches of science. That idea was clearly present in the discussions at the recent British Association Conference on Science and Industry, but industrial experience as a whole scarcely suggests that the average research worker finds it as difficult to fit into an interdisciplinary team as the present paper implies. Both the competitive and co-operative habits can be encouraged in the process of learning, but much also depends on the personality of the individual worker.

The real case for stimulating supervision of the type here suggested, with its consciousness of scientific and social responsibilities, is the spur it gives to creative thought at the borderline of the sciences concerned. That as well as the encouragement of habits of co-operation and understanding is the outcome of broadening the background of the student and integrating the discipline he primarily follows more closely with the field of knowledge as a whole. Dr. Brozek and Prof. Keys rightly point to the value in this respect of a course in the philosophy of science, and they stress particularly the importance of including the theory of meaning and the study of verbal and non-verbal symbols used in representing scientific concepts and their combinations, the logic of the scientific method which deals with experimental design, collection of data, analysis of the error of measurement, process of inference and testing of hypothesis, and the concrete logic or systematology of the sciences based on analysis of their subject-matter and methods used.

Much of course would depend on the way in which such philosophy is taught; but beyond this, stress is laid on the necessity of working facilities for getting acquainted with the problems and methods of neighbouring fields, and familiarity with current problems. These, in fact, rather than the development of social skills, are the essential factors for stimulating an effective scientific co-operation; but in actual practice the methods and organization developed at the Laboratory of Physiological Hygiene at the University of Minnesota do not appear to overstress the third factor, and they provide ample encouragement for individual initiative and personal responsibility. It is worth recalling that something of the same kind of plea for the teaching of philosophy was voiced in respect of engineering at a Conference on Industry and University Education held last December in London by the Vacation Work Committee of the Imperial College of Science and Technology (see *Nature*, March 31, p. 402); and the article on "The Churches and European Reconstruction" which the Bishop of Chichester contributed to a recent number of the *Contemporary Review* is important for the same emphasis that is laid on the need for a spiritual unifying force, to be found not merely in science, which will restore hope and purpose.

This emphasis on the importance of the unity of knowledge is to be found in other discussions which have centred around the universities and their functions in the modern world. Prof. Manson's address, referred to above, was largely concerned with the part which the universities might play in restoring a measure of unity to civilization if they set their own house in order by clearing themselves of the charge which the late Archbishop of Canterbury once levelled against them in a sermon before the University of Oxford, that a university "is a place where a multitude of studies are conducted, with no relationship between them except those of simultaneity and juxtaposition". That is a problem which must be frankly faced in dealing with the reconstruction and expansion of the universities. It is germane to the fundamental questions as to the functions of the universities and their place in the society of to-day, and was indeed frankly faced by both Dr. Lowe in "The Universities in Transformation" and by F. R. Leavis in "Education and the University".

More recently, the whole question has been very concisely but admirably discussed by Prof. John Macmurray in his article "The Functions of a University" in the *Political Quarterly*. Prof. Macmurray, stressing the cultural function of a university as the key to its functions of research and of teaching, urges that the life of a university should be effectively bound up with that of society about it. This cultural function cannot be fulfilled decisively unless the university is a place where knowledge is unified and not merely a common house for disjointed specialisms, and unless this unification is in constant and vital relation to the cultural life in the community around the university. A university must be designed to encourage and facilitate the interchange of knowledge through which it can become a spiritual whole; but the departments of knowledge can only be unified in the active life of a human community.

It is in this cultural function that our universities are most conspicuously failing, and that is essentially the point of Mr. A. S. Nash's criticism in his more recent book "The University in the Modern World". Prof. Macmurray lays the responsibility for this failure rather on the disintegration of traditional culture than on the universities themselves, and although he makes no suggestions as to how these three functions can be effectively discharged under modern conditions, he looks forward with some confidence. The use of science for social ends demands a unity of purpose in society which must express itself in, and depend upon, the achievement of a cultural synthesis. Changes in social structure and social outlook are taking place which will alter the demands made upon all our educational and cultural institutions, and Prof. Macmurray looks to a period of social and cultural unification. His paper, no less than that of Dr. Brozek and Prof. Keys, is a challenge to the critical and constructive thinking on the ultimate functions of the university and its place in modern society which must precede the adaptation and reorganization of its structure and methods, so as to serve these aims and functions more effectively in the new age.

A LANDMARK IN ALGOLOGY

The Structure and Reproduction of the Algae

By Prof. F. E. Fritsch. Vol. 2: Foreword, Phaeophyceae, Rhodophyceae, Myxophyceae. Pp. xiv+939. (Cambridge: At the University Press, 1945.) 50*s*. net.

WITH the publication of this volume the whole botanical world, and algologists in particular, owe a special debt of gratitude to Prof. Fritsch. Although ten years have elapsed since the appearance of the first volume, it is no mean achievement under present conditions to have produced this companion work, and both Prof. Fritsch and the Cambridge University Press are to be congratulated on their courage and determination.

The two volumes virtually represent Oltmann's brought up to date and greatly expanded, and they will undoubtedly form the algologist's *vade mecum* for many years to come. Considerable advances have been made since the last edition of Oltmann's was published, and a new work, preferably in the English language, was plainly demanded. The labour involved in the preparation and execution of such a task is enormous, and Prof. Fritsch can look back with every satisfaction upon his handiwork. This and the companion volume alone would ensure him the immortality of the earlier great algologists.

The real reward for producing such a book must ultimately lie not only in the stimulus it gives to research but also in its influence in directing future research. This second volume should exert a profound effect upon both. The publication of such a book is obviously the moment to reflect upon the present position of algology. It is clear that in recent years the principal advances in the morphology of the brown algæ have been mainly in certain groups, for example, Fucales, Ectocarpales; whereas in others, for example, Laminariales, there has been little further progress. In the Rhodophyceæ the extensive work of Kylin and other Scandinavians has opened up much that was unknown, the frequent use of Kylin's figures being eloquent testimony of his contributions. In reading the present volume one cannot but be impressed by the extensive advances in knowledge, but at the same time the remaining lacunæ obtrude upon our notice. In general, more work is needed, especially by those favourably placed, upon tropical and southern hemisphere genera. In particular, *Analipus*, *Arthrocladia*, *Adenocystis*, *Dictyotopsis* and *Padina* among the Phæophyceæ need further study; the Encœliaceæ, Tilopteridales and extra-European Sporochnales have many secrets still to yield, and cytological investigation is sorely required in *Soranthera*, *Ascocyclus*, *Ectocarpus Lebelii* and *Sphacelaria*. Similarly in the Rhodophyceæ, outstanding problems could be assisted by a study of the development of *Delesseria* and *Nitopyllum*, and by investigations of the genus *Compsopogon*, the Sarcomeniæ and the parasitic Florideæ as a whole. The cytology of *Galaxaura* and the Gelidiales is practically untouched, and the absence of female plants in *Rhodymenia palmata* and *Halosaccion ramentaceum* is no mean problem. In the Myxophyceæ, the Entophysalidaceæ and Pleurocapsales are most in need of attention. The above are just a few of the lacunæ that need to be filled.

The concept of heterotrichy, one of Prof. Fritsch's greatest personal contributions to algology, pervades the volume, and for the first time one can see it in full perspective. Here one regrets that Prof. Fritsch's four recent studies in comparative algal morphology were not included in this volume, because they form a summary of the valuable material contained in this book. It is still painfully evident that we are no nearer solving the puzzle of the origin of the Phæophyceæ and Rhodophyceæ. On the other hand, recent cytological work suggests that we might well abandon the old concept of alternation of generations and refer rather to alternation of phases (*v*. Drew, *Ann. Bot., Lond.*, N.S. 7, 23; 1943). In this connexion one feels that the term triplobiont might well have been introduced, as indeed it has been by Drew, to cover those cases among the Rhodophyceæ with a triploid phase. Thus the statement on page 415 that the remaining Rhodophyceæ are diplobiontic is somewhat misleading.

I am not certain that the fundamental change of arrangement adopted for the treatment of the Rhodophyceæ is advantageous, because in some cases members of the same family (for example, Corallinaceæ) are treated pages apart. This, however, is not necessarily an opinion that will be shared by others.

It is a vain hope these days for authors not to expect their books to become out of date in minor details almost before they are published. Thus, the freshwater Phæophyceæ are no longer restricted to the Ectocarpales, for in 1943 a freshwater member of the Sphacelariales was reported from China, while in the same year David published an important contribution on the growth and ecology of *Ascophyllum*.

For most research workers the intrinsic value of this book will lie in the magnificent collection of references to the extensive literature. Here everyone will acknowledge the great debt we owe to Prof. Fritsch. The author says that the section on ecology is not exhaustive, but at the same time one would have liked to see some reference to Bokenham's work on algal recolonization, and also to the splendid series of biotic studies of the South African intertidal zone by Stephenson and his co-workers, whose results are independent of those of Isaac. In the section on salt marsh fucoids, there is no reference to two relevant papers on American salt marsh algæ. In other parts of the book the important review paper by Hoffmann on the utilization of seaweeds is missing, and there is also more recent literature than that quoted on alginic acid and agar. Morphologically, the principal omission is the important work of Kirijeva and Shapora on growth and reproduction of *Laminaria* in Kola Fiord, while the work of Zinova on the same genus is also not mentioned. In the genus *Dictyota*, Collins, as well as Holden, has recorded the presence of antheridia and tetraspores on the same plants in one species, *D. indica*, the tetraspores not undergoing normal division.

In a work of this magnitude it is inevitable that small points should be overlooked, but this reflects no discredit on the author; rather the reverse because, although the field is so vast, the omissions are almost negligible. However, one would like to have seen some reference to the morphology of those interesting endophytes, *Schmitziella mirabilis* and *Rhodochorton endozoicum*. Some reference might also have been desirable to the three physiological races of *Laminaria cloustoni* described by Montfort; further, there is no mention of the galls caused by the nematode *Tylenchus fucicola* on *Ascophyllum* and *Desmarestia*, although there is a reference to similar galls in the *Rhodophyceæ*. Mention is made of the use of brown algæ for the

manufacture of potash, but this industry really commenced with the use of the Fuci as a source of soda for glass and glazing. *Rhodymenia palmata* with 0·7 per cent iodine contains more than *Trailiella*, while *Phyllophora nervosa* is so rich in this element that the Russians use it as a commercial source of iodine. Some of the algæ are also richer in protein than is indicated; for example, *Porphyra tenera* (28 per cent) and *Undaria pinnatifida* (11 per cent).

The great care expended by Prof. Fritsch on this work is seen in the almost entire lack of printing errors. The most important of these are several references to Maps 1 and 2, said respectively to be on pp. 8 and 250, whereas both are at the end of the volume. The footnote on the reproduction of *Hildenbrandia rivularis* is somewhat confusing, and in conjunction with the text leads one to think that the genus has no reproductive organs. Nearly all the numerous illustrations are of excellent quality, but it is evident that some, for example, Figs. 6 *D*, 36 *A*, 91 *G*, 199 *H* and 289 *E* have suffered severely in reduction, and the photographs, Figs. 64 and 117 *B*, also are not very clear.

All these points, however, are but minor details in a volume that is of first-class importance. Its production has restored the prestige of English algology built up by the workers of the last century. It is a volume that all who can afford it should possess, and no library should be without it. The Cambridge University Press is also entitled to congratulations on producing such a well-constructed book in wartime.

V. J. Chapman.

TWO FARMERS LOOK BACK

Farming Memoirs of a West Country Yeoman

By S. G. Kendall. Pp. 247. (London: Faber and Faber, Ltd., 1944.) 12*s*. 6*d*. net.

Thirty Years Farming on the Clifton Park System

How to Supply Humus, Texture and Fertility by the aid of Deep-Rooting Grasses. By William Lamin. Pp. 110+3 plates. (London: Faber and Faber, Ltd., 1944.) 7*s*. 6*d*. net.

ANYONE who knows an English village well knows that there is usually someone with a gift for telling a story, developed perhaps in the friendly atmosphere of the 'farmers ordinary', or even in the alehouse or in the camaraderie of farm work. Some combine this with another gift, the ability to put the story into writing. In recent years there have been many discoveries of these talented people, and they have been encouraged to write down what they have to say. Messrs. Faber and Faber have been particularly successful in finding some of these men and they have recently issued several books, each a first effort, by a farmer whose story would otherwise never have got beyond his own village.

One of the latest is the "Farming Memoirs of a West Country Yeoman" by S. G. Kendall. It is in many ways a remarkable production. Mr. Kendall has been farming all his life near Bath, as his father and grandfather had done before him: he is now nearly eighty-six, so that the joint lives of all three stretch over a considerable period. He begins his book with an account of the disastrously wet harvest of 1860, when the grain sprouted badly in the stook and the flour yielded a dough which would neither rise not bake properly, so that the inside of the loaf was stodgy and sticky with a sickly, sweet, unpalatable flavour. Two knives had to be used, one for the actual cutting, the other to clean the first knife before it would cut again. But the housewives of those days were very ingenious: they met the difficulty by leaching wood ashes with boiling water, allowing the insoluble material to settle, and taking off the clear liquid (which was mainly a solution of potassium carbonate) and using it for making the dough. The improvement was considerable, though the result was still not entirely satisfactory.

In those early days the main products of a Wiltshire farm were sheep and corn: the dairy cows were let to a dairyman at a certain price per head per annum; he tended them, made butter or cheddar cheese; in addition, he could keep as many pigs as the accommodation permitted. The farmer replaced any cows that died and provided some of the milkmen.

Agriculturists will read with interest the author's short summaries of the various seasons. 1874 was the peak of success: yields of corn were good, prices were "fairly remunerative", while values of beef, mutton, milk, butter and cheese all steadily increased —the result, in his view, of the Franco-German war. A considerable amount of labour was needed, but it was always forthcoming; the men worked well and willingly. Hours were very long: work in harvest time began at 3 a.m. and went on until dusk; wages were low—13*s*.–15*s*. a week—families were often large, and at the end of a strenuous life the workers could look forward only to the workhouse, or, if they wished to stay outside, to a Poor Law pension of 2*s*. 6*d*.–4*s*. a week with or without a loaf of bread. During their working lives there were, of course, compensations: Harvest Homes, Christmas feasts, fairs, etc., and clearly the workers enjoyed life, but undeniably it was very hard. Their diet must have been good, for they were very strong.

The year 1877 was not a bad season; wheat sold at £3 per quarter. The worst season of the nineteenth century was 1879 by reason of its cold, wet summer and harvest, and in the following season, 1880, there were considerable sheep troubles. 1881 was better so far as yields and quality were concerned, but prices were falling; by 1886 the combination of bad seasons and low prices had forced many farmers out of business and many farms were derelict. 1891 and 1892 were both difficult years; 1893 was second only to 1879 for utter badness, but this time it was from excessive drought—a most unusual cause for low yields of grain. To make matters worse, prices collapsed—the result of a financial crisis in the western States—and the miserable yields of wheat sold for only 23*s*. a quarter; sheep and lamb prices were also low. Things improved later, and Mr. Kendall was able to keep going.

The agricultural details, however, are only part of the interest of the book. It is a very human document, and Mr. Kendall has a keen eye for the beauty of the countryside and a very lively interest in the doings of country people. So he gives accounts of feasts and weddings, of dances, skating and political meetings in barns, of exciting rescues of cattle from a disastrous flood and of sheep from a severe snowstorm, and of other events—all written in a vivid, sometimes eloquent, style and interspersed with a wide range of quotations from "Alice", Southey, Burns, Charles Kingsley and others. He modestly does not publish photographs of himself, but we can perhaps picture him as the modern counterpart of another but much earlier nineteenth century farmer, also a great reader of poetry with an eye for the

beauties of Nature—Mrs. Gaskell's "Thomas Holbrook". The general reader will enjoy the book as much as the agriculturist.

Mr. Lamin's book is altogether different in character. It is written for farmers by a farmer, though its scope is a good deal wider than the title indicates. He also is well over eighty years old; he writes clearly and he has a good story to tell. The son of a farmer, he worked on his father's farm near Nottingham until he was twenty-four, when his father set him up as a butcher. But the call of the land was too strong, and after five years he took the farm next to his father's: a poor, run-out sandy stretch, its soil liable to be blown away in a high wind, washed away in high rain, or scorched on a hot day. It had been unlet for nineteen years. He struggled on for five or six years, then came across Mr. R. H. Elliot's book describing the system followed at Clifton Park. This book made a great stir in its day, and it is still useful now: Messrs. Faber and Faber have, in fact, re-issued it. Like other agriculturists of his time, Mr. Elliot did not think the sub-soil on his land was adequately treated, and in his seeds mixture he included some deep-rooting plants that would open it up. The idea appealed very much to Mr. Lamin, and he thought that if he could get enough fibrous root material into the surface and the subsoil of his farm he would not only fix the soil but so enrich it in humus that he would greatly increase its productiveness. So he evolved a seeds mixture on Elliot's lines including cocksfoot, meadow fescue, rough-stalked meadow grass; Montgomery red, Aberystwyth white and Kentish white clovers; chicory, burnet, yarrow and sheep's parsley. This was left down for four years and each year gave excellent crops, finally leaving the soil enriched with a good turf and a mass of deep roots that not only stopped the loss by blowing away and washing, but also made an admirable foundation for the succeeding crops: oats, potatoes, silage crops, etc. He would not, however, include rye grass in his mixtures.

Mr. Lamin used artificial fertilizers liberally, and has some rather scathing things to say about those who claim that they are ineffective or even harmful.

The book contains a great number of practical details of considerable agronomic interest and not easily accessible elsewhere, and it records an achievement of which Mr. Lamin may well be proud.

E. JOHN RUSSELL.

THE COUNTRY TOWN

Country Towns in the Future England

A Report of the Conference representing Local Authorities, Arts and Amenities Organizations and Members of the Town and Country Planning Association on the 23rd of October, 1943. Edited by Stanley Baron. Pp. 140. (London: Faber and Faber, 1944.) 8*s*. 6*d*. net.

THE main title of this book is somewhat of a misnomer. The book is a straightforward report of a conference held in the autumn of 1943 under the auspices of the Town and Country Planning Association, at which representatives of some ten per cent of the smaller towns of England were told how to plan to get more industry and better amenities into their boroughs. Short speeches were made by representatives of five of the towns themselves: a health resort (Malvern), a garrison town (Richmond, Yorks), an agricultural centre (Wisbech), a 'one-industry' weaving town (Haslingden) and a moribund ancient borough (Brackley). Conditions were very different, but all advocated the same solution—new light industries.

It was left for Prof. Ashby, in opening a discussion, to make much the most important contribution to the conference and to this book. He carefully analysed the reforms that the small country towns must undertake before they can become attractive habitats for the staffs of decentralized industry. He also reminded the conference that in the last resort the economic welfare of the country town is dependent on the well-being of its surrounding agricultural and village communities. The primary requirements of a country town are: suitable facilities for marketing agricultural produce; adequate transport arrangements for goods and passengers; a full range of supply services in agricultural requirements; a choice of banking services; a full range of supply of retail shopping facilities; a choice of good repair and maintenance garages; an adequate supply of cafés and restaurants; an adequate supply of hotels, as well as of public houses; at least one good cinema; and provision for technical education. The smallest town able to provide these requirements in full would have at least 7,000 inhabitants, and more often 10,000.

The course of action that should be followed by country towns which wish to attract industry was outlined by Mr. R. L. Reiss, deputy chairman of Welwyn Garden City, and Mr. T. A. L. Paton. They put forward the following desiderata: grouping of factories to spread costs of public utility services; good road communications; building sites at least 200 ft. deep and 100 ft. wide, the building line set back 25 ft. from a 50-ft. road; railway sidings for a few larger factories, which must have sites at least 700 ft. deep; single-story factories built to rent, each with a 40-ft. frontage and depths varying from 65 ft. to 100 ft.; building to cover only 20 per cent of the total area of the industrial estate when fully developed in order to leave sufficient elasticity for necessary expansions and avoid the creation of a factory slum. Pre-war development costs were £800–£2,000 an acre before the first brick of a factory was laid.

The third session was devoted to amenities and was addressed by Miss Glasgow, secretary of the Council for the Encouragement of Music and the Arts. She said that places of about 30,000 population should be able to support a theatre seating 700–800, a concert hall, a library, an exhibition gallery and several cinemas. In towns of some 20,000, the theatre would probably also have to serve as a concert hall and public meeting place, and might well have an exhibition gallery as an annexe. With less than 10,000 people, townships could only support a community centre; this should not consist of one elaborately equipped hall, but of a group of smallish rooms to form a library, an art room, a little theatre and a music room.

In the book these constructive suggestions are surrounded by much general discussion, but the whole makes interesting reading, and (together with the National Council of Social Service report "Dispersal") is a useful corrective to the view that the re-location of industry can be settled by engineers, based on the suitability of each site from considerations of raw materials, transport and markets.

J. TYRWHITT.

NATURAL HISTORY OF GRANITE

By PROF. ARTHUR HOLMES, F.R.S.

FOR a century and a half the origin of granite (including granodiorite) has remained one of the most intractable and controversial of the problems geologists have tried to solve. Fouqué and Levy's comment in 1882, that "it excites the most lively discussion", is as true to-day as ever before; and indeed might be regarded in some countries as a mild understatement of the passions that are aroused by apparent conflicts of evidence and very real conflicts of opinion. Hutton clearly established the status of granite as a crystalline plutonic rock, but the French geologists and Lyell and his followers soon realized that not all granites are necessarily of igneous origin. Some occurrences were seen to have no sharp contact against the aureole of metamorphic rocks, but to merge into the surrounding schists through a transitional zone of gneisses and felspathized schists so gradually that at no point could it be said that the rock ceased to be metamorphic and became igneous. These granites consequently came to be regarded, not as representing the cause of metamorphism, but as being the extreme products of its action.

Discussion thus became focused on the question whether a given mass of granite had crystallized from an intrusive magma which mechanically displaced the pre-existing rocks, or whether the granite had been made out of the pre-existing rocks by some process of ultra-metamorphism which was thought to culminate locally in actual fusion. The extreme magmatists have since come to admit that magma may react with the invaded rocks and assimilate the products; while adherents of the metamorphic view have realized that chemical changes are essential for the formation of granite, and that the pre-existing rocks must therefore have been permeated by granite magma or its derivatives (including the *ichor* of Sederholm and the hydrothermal solutions favoured in America), or by more tenuous migrating materials of unspecified origin, referred to as mineralizing agents or emanations. Between these limits of interpretation, many grades of opinion have been held, especially as regards the origin of granite magmas. Those who insist that all granites are igneous accept granite magma as having been available, either in its own right or, more recently, as a residual magma thought to have been derived by fractional crystallization from an antecedent basaltic magma. Those who regard granites as having been largely formed from the pre-existing rocks recognize that they passed through a stage when part of the material was mobile or fluid. The partially fluid mash has been styled *migma* by Reinhard, to distinguish it from a mash consisting of incompletely crystallized magma. Moreover, magma may be generated from migma either by the attainment of complete fluidity or, at any stage, by the squeezing out of the fluid portion.

It is unfortunately not generally realized that the battle between rival camps has been repeated more than once, with varying fortunes at different times and in different countries. Most of the older English-speaking petrologists of to-day were brought up, like myself, in the faith that granite, being by definition an igneous rock, must have crystallized from a magma; and many of us have had to rediscover for ourselves that the plutonic characters of granite are not in themselves a guarantee of igneous origin: a fact, long overlooked, to which Scheerer had already specifically directed attention so early as 1847. Still worse, we were left in ignorance of the stimulating ideas of the French school, or with the impression that they were old-fashioned and unworthy of serious consideration. Looking back, it is obvious that a carefully balanced historical introduction would have dispersed the fog of dogma and prejudice in which we were unconsciously groping. But no one had undertaken the arduous task of preparing such a survey, and in its absence enlightenment was slow and largely dependent on the luck of one's personal experience in the field. Iddings[1], it is true, had published a historical review of the origin of igneous rocks in 1892, but this dealt mainly with volcanic rocks and their magmas, and neither the problems associated with granite nor the achievements of the French school were as much as mentioned. Now, half a century later, full amends have been made to the masters of the past in two illuminating presidential addresses delivered by Prof. H. H. Read[2] to the Geologists' Association, the keynote being Hutton's remark: "I have been particularly anxious about this subject of granite". Fortunately, our historian has a background of field experience that ensures sympathetic and competent judgments. Inevitably he holds up the mirror to himself as well as to others, but only to reveal himself as a good-humoured guide who neither claims authority nor acknowledges any, save only in the rocks themselves.

One of the 'high lights' of the story is the record of the great contributions made by the French, a record which anticipates in the most remarkable way the more detailed developments of recent years. In 1824 we find Ami Boué describing what would now be called granitization, and suggesting that the passage through crystalline schists of heat and gaseous exudations from the earth's interior was responsible for the growth of veins and disseminated crystals, and eventually for "a kind of igneous liquefaction". In 1837–38 Fournet distinguishes metamorphic rocks due to simple recrystallization from others in which partial melting has occurred, combined on occasion with inward and outward migrations of material. In 1841 Deville introduces the idea of mineralizing agents—gases which carry mineral matter and so chemically transform (as we should now say, by metasomatism) the rock substances through which they diffuse. In 1844 Virlet d'Aoust uses the term *imbibition* to express the idea that igneous materials have soaked into metamorphosed sedimentary rocks and transformed them into granite. Shortly afterwards, in 1847, he speaks of the process as *granitification*. In the same year, Fournet notes that, in certain metamorphosed sediments, far more felspar has developed than could possibly be accounted for by simple recrystallization, and so provides evidence that introduction of material must have taken place. In 1869 Delesse submits the hypothesis that granitized plutonic rocks may become so mobile that they can be squeezed towards the surface, to form intrusive granites at high levels in the crust, where they may have lost all the characters from which their true origin could be determined.

Before considering one of the major turning points in the history of petrogenesis which was now approaching, it is of interest to see what was happening in the British Isles during the rise of the French school. Following Lyell's suggestion, 'metamorphic' granites had been widely claimed in Scotland and Ireland, but more stress was given to heat and fusion, partial

or complete, than to change of composition and fluxing by introduced materials. In 1862 Scott and Haughton advocated a twofold origin for the granitic rocks of Donegal, of which they recognized both metamorphic and intrusive varieties. In 1871 Green[3] described the vestiges of bedding that visibly remain in the granite of the Errigal district; and suggested that in places these ghost-like structures had been destroyed by fusion, and that the fused material, in virtue of its superior mobility, had behaved intrusively. The objection that in order to convert sedimentary rocks into granite certain missing substances would have to be restored was apparently not realized. A few years later this difficulty was independently faced by Clifton Ward (1876) on lines that the French work should already have made familiar. Discussing the origin of the granites of the Lake District, he writes: "Although a simple melting down might never produce granite, yet a moist fusion, accompanied by elementary substances, brought upwards from still greater depths, might effect a great transformation". Ward's suggestion was stillborn, and the old ideas lingered on in Ireland until adverse criticism from Callaway[4] and Bonney, whose sympathies were with Rosenbusch, finally banished 'metamorphic' granite from the pages of the memoirs of the Irish Survey.

The critical year appears to have been 1877, when Rosenbusch[5] published his classic work on the contact metamorphism of the slates around the granite of Barr-Andlau (Vosges) and showed by a series of chemical analyses that there was no significant change of composition in the altered rocks as they were traced towards the margin of the granite. Having found in this example no evidence of transfer of material into the country rocks, Rosenbusch afterwards denied the very possibility of such permeation, and claimed that the gneisses and felspathized schists which elsewhere appeared to demand introduction of granite-making substances were themselves merely granites that had suffered dynamic metamorphism during orogenic movements. Like Werner, Rosenbusch attracted from abroad many students who afterwards achieved fame, and so great was his authority—outside France—that his doctrines dominated petrological opinion for two generations.

The French, however, did not allow their case to go by default. Barrois (Rostrenon, 1884), Michel Levy (Flammanville, 1893), and Lacroix (Pyrenees, 1898–1900) found large, well-shaped crystals of orthoclase, identical with those of the adjoining porphyritic granite, not only in the sedimentary schists outside the granite, but also in enclaves of similar material occurring within the granite. Neither the felspars nor the granites show any sign of dynamic metamorphism, and the structures are entirely different from those of, say, the Mont Blanc granite, which has demonstrably been sheared. The crucial nature of the evidence provided by the 'big felspars' has long been realized, since no one has seriously doubted that they must all have shared a common origin. Either they grew in solid rock or they crystallized from a magma: identical felspars could not be assumed to have originated in two entirely different physico-chemical environments. Those who believed that they could form only by crystallization from a magma resorted to various expedients to avoid the disturbing implications of their presence in contact zones and enclaves. Rosenbusch stubbornly maintained his earlier interpretation, to the justifiable astonishment of Lacroix. Actually, the possibility of transfer of silicate-making materials was never widely admitted until the publication of Goldschmidt's proof (1921) that influx of silica and soda had accompanied the contact metamorphism of pelitic rocks in the Stavanger area. Before this convincing demonstration, and even afterwards, Cole[6] (1915) and Thomas and Campbell Smith (1932), among others, took refuge in the unmanageable hypothesis that the big felspars had somehow been bodily introduced from an assumed magmatic source. A fatal objection to this awkward idea is that the felspars are to be found in obviously sedimentary contacts and enclaves, among which, as Read points out, there are examples where "delicate bedding displayed often in three dimensions, is not disturbed in the least". Innumerable exposures show that the felspars cannot have been introduced mechanically. Harker ignored or minimized the evidence, and many other petrologists preferred to remain silent on the matter, presumably because they had nothing to say about what could not be understood. Nevertheless, a definite and far-reaching conclusion can be drawn in all cases where it can be established—as it generally can—that the felspars did not grow as 'porphyritic' crystals of post-granite formation. To quote Read: "Where the xenoliths [enclaves] containing the felspars are sedimentary, then what encloses the xenoliths and similar felspars is also sedimentary—the porphyritic granites are produced from the sediments by an intensification of the felspathization process"; and, he pertinently adds, no one can *demonstrate* a magmatic origin for the porphyritic granite which contains the 'xenoliths'.

Meanwhile, as a result of several comparative studies of felspathization and granitization, the French geologists became convinced that these processes increase in intensity downwards until the contact zones of the higher crustal levels merge into regions where the rocks have been quietly made over into granite without significant disturbance of the pre-existing strata. Both Michel Levy and Lacroix thought of the active agent as granite magma, but Lacroix makes it clear that the magma must have been chemically and physically very different from merely molten granite, since it generates granite only after incorporating the schists that were there before the granite. Termier (1904 and 1910) developed this conception to its logical conclusion by pointing out that the active magma envisaged by Lacroix could itself be accounted for in terms of pre-existing rocks and highly energized emanations. He speaks of the latter as *colonnes filtrantes*, which rise from the depths into, say, geosynclinal strata, adding energy and exchanging new elements for old as they ascend and spread out. Where the intensity is greatest the rocks are granitized and locally transformed into magma, while the displaced elements are driven forward with the other migrating materials in an advancing and slowly declining wave of metamorphism. Part of the magma generated in depth may invade the superstructure, forming granite intrusions with contacts of various kinds, including those of Rosenbusch's Barr-Andlau type. For Termier, regional metamorphism and intrusions (at all levels) "are but two effects of the same cause". Although Termier's impressive synthesis was too imaginative to command serious attention, it nevertheless foreshadowed much of the progress that has since been made in this complex field of research. In particular, we find in it a revival of Fournet's early hint of what has recently come to be known as the advance of the 'migmatite front'.

The term *migmatite* was proposed by Sederholm for rocks which suggest by their appearance that they originated "by the mixture of older rocks and a later erupted granite magma". Along the shores of southern Finland and its fringing archipelagoes, the wave-swept rock surfaces display spectacular examples of all the phenomena associated with granitization. By means of a series of lavishly illustrated memoirs (1907–34), as well as by conducting several international excursions, Sederholm made these challenging exposures so generally familiar that the baleful influence of the Rosenbusch school was at last effectively countered. Sederholm did not maintain his first conviction that what had injected and permeated the older rocks was a primary granite magma, but he seems never to have abandoned altogether the idea—although he wavered at times—that such magma was the ultimate source of the invading materials. He envisaged an ultra-metamorphic process referred to as *anatexis*, involving injection, solution, refusion, assimilation and differentiation, whereby new magma was formed. The newly born magma, having the original granite magma and the country rocks as its parents, became available in its turn for further migmatization. Later, he ascribed less importance to granite magma, whether primary or secondary, and more to what he called *ichor*, a derivative magmatic solution highly charged with water and other volatiles, and thereby endowed with great penetrative power. The primary granite magma thus became only a grandparent of the second generation of ichor. The weakness of this conception lies in the implication that relatively small quantities of ichor, though derived by magmatic differentiation, had nevertheless sufficient energy and chemical activity to promote anatexis on a regional scale and so to make more magma and more ichor out of large quantities of country rock. Evidently if the immigrating materials are to be capable of effecting granitization or anatexis on the scale observed, they must differ fundamentally in properties and origin from the late-stage exudations of a granite magma as ordinarily conceived. For this reason the neutral term *emanations*, which is free from genetic implications, is now coming increasingly into favour.

Wegmann, now Argand's successor at Neuchâtel, has greatly clarified our ideas by the results of his long and detailed field studies in Finland (1931, in collaboration with Kranck) and Greenland (1935 and 1938). Wegmann is especially interested in the mechanism of *stoffwanderung*, the migration of atoms involved in migmatization and granitization, and has made familiar the concept of an advancing migmatite front. He is also a pioneer in the attempt to unravel the complex relationships between orogenic movements and atomic migrations. He draws a graphic distinction between :

(*a*) migration of elements through a framework of earlier rocks which remains stationary and so retains its former structures, despite extensive exchange of materials and recrystallization ; and

(*b*) migration through a framework which is itself deformed by movements during or after the migmatization ; in this case relative movement between the more mobile migmatized parts and the more rigid parts of the framework leads inevitably to intrusive contacts ; and when, as must often have happened, the final crystallization of such mobile masses outlasts the movements, the ancestral structures are obliterated, except perhaps for a few schlieren and enclaves, and the eventual result is a more or less massive granite.

The leading exponent of the subject in Sweden is Backlund, whose views have developed along essentially similar lines. He has particularly discussed the transformations of rocks such as limestone, quartzite and metabasite and has shown how selective and progressive metasomatism dispels the chemical difficulties that seemed insuperable to Callaway and Bonney and, more recently, to Harker and Niggli ; the granitizing materials that are retained and fixed vary with the composition of the rocks that are being granitized. He has also stressed the important fact that granitization has been a normal accompaniment of orogenesis throughout geological time. Read gives an admirable account of these recent Fennoscandian developments, including a summary of the spirited debate between Backlund and von Eckermann (1937–38) on the genesis of the rapakivi granites.

The geochemical relationships involved in granitization can be briefly summarized in the formula : granite = pre-existing rock *plus* added material (A) introduced by and abstracted from the incoming emanations ($A + x$), *minus* displaced material (B) driven forward with the outgoing emanations ($B + x$). When successive stages of the transformation of pre-existing rock into granite can be seen in the field, it is possible (provided that there has been no significant volume change) to determine A and B. The most notable work along these lines has been that of Doris L. Reynolds[7]. In the course of her investigation of the Newry complex, she has proved by chemical analyses of carefully correlated specimens that the minimum introductions (A) required for the granitization of the country rocks were sodium, calcium and silicon ; while, after several intermediate exchanges that are traced in detail, the displaced materials (B) eventually carried forward consisted of aluminium, iron, magnesium, potassium, hydrogen, titanium, phosphorus and manganese. The latter, together with some remaining sodium, calcium and silicon, became fixed in adjacent bands of hornfels which were thereby basified and transformed into rocks chemically equivalent to certain varieties of quartz-diorite. From these results and other relevant evidence, Dr. Reynolds concludes :

(*a*) that the introduced material ($A + x$) cannot have been an ordinary magma, since x has left no recognizable traces in the rocks ;

(*b*) that the basic material migrating from a region of granitization, besides enriching the surrounding aureole in biotite and other minerals, was probably also responsible for the 'igneous-looking' basic and ultrabasic rocks that overlie the granitic rocks of many plutonic complexes ; and

(*c*) that before a given mass of country rock was actually granitized, it passed through a preliminary stage of basification.

From the nature of the case, little can be said about the ultimate source of the granite-making emanations. The granophyric contact zones and rheomorphic veins locally associated with dolerite sills and dykes in non-orogenic regions[8] indicate that at least some basaltic magmas have been capable of providing a limited supply. In depth, basaltic magma may be a potential source of considerable importance. In orogenic regions, however, attempts to relate the emanations to the supposed magmas of associated basic rocks are weakened by the possibility, in some cases confirmed, that such rocks have themselves originated as complementary by-products of the granitization process. The major processions of emanations may conceivably be liberated from abyssal magmas by differentiation,

or squeezed out of the intensely sheared roots of growing mountain ranges; or they may have a source of some quite unsuspected kind. But our ignorance of the source of orogenic emanations in no way militates against the evidence of their passage through the rocks. The origin of basaltic magma remains equally uncertain, despite many optimistic suggestions to the contrary. Read quotes with approval Kennedy's recognition (1938) of two contrasted expressions of magmatic activity, distinguished respectively as:

(*a*) *volcanic* associations, derived from a parental basaltic magma which originates by the remelting of the earth's basaltic layer; and

(*b*) *plutonic* associations, derived from a parental granodioritic magma which originates where tectonic thickening of the crust brings the 'granite' layer within the range of melting; the ascent of such magma is preceded by an advancing wave of granitization and migmatization.

Since 1938, more precise estimates have been made of the heat generated in rocks by radioactivity, and of the crustal heat flow that escapes at the surface in Britain, South Africa and eastern North America. The results imply that in these non-volcanic regions the normal granitic and basaltic layers fall short of the temperatures required for magma formation by several hundreds of degrees[9]. In the light of the evidence now available, we can do no more than speculate as to how basaltic magma comes into existence. Where the granitic layer is greatly thickened in the roots of mountain ranges, the temperature at the base might eventually rise to the point required to start selective fusion, but many millions of years would be required, and even then latent heat would have to be supplied. The suggested process therefore fails to account for the observed fact that granitic rocks began to be formed (at levels well within the range of subsequent denudation) *while* the orogenic movements were actively in progress. Thus the whole problem of magma generation, apart from the possibilities associated with the emanation hypothesis, is still as baffling as ever.

There remains for consideration the all-important space problem: How have large masses (batholiths) of granitic rocks come to occupy their present positions, and what has happened to the rocks that were previously there? The bodily intrusion of gigantic volumes of magma appears to be mechanically impossible; and, as Read puts it: "The only solution is to suggest that in fact no large bodies of granitic magma were in existence. The large granite masses result from replacement, they are granitization products. Many of the small granites may of course also be of the same origin, but some of them may result from the consolidation of migma and some from the consolidation of magma. Thus, though there may be granites and granites, most of them are of one kind and all of them may likely be of one connected origin." With this conclusion I am in full agreement.

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VARIATIONS IN THE COMPOSITION OF THE SEA IN WEST AFRICAN WATERS

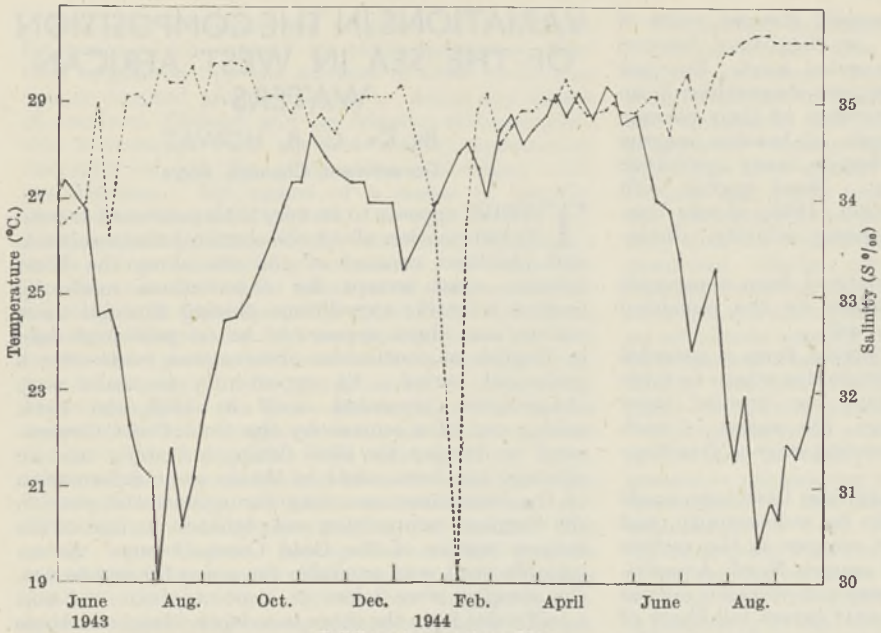
By DR. G. R. HOWAT
Government Chemist, Accra

THERE appears to be very little published scientific information about the chemical characteristics and plankton content of the sea along the West African coast except for observations made by various scientific expeditions passing through these waters, and there appears to be no published data in English of continuous observations made over a prolonged period. An opportunity to make such observations presented itself in 1943 and 1944, arising out of a scheme by the Gold Coast Government to develop the local fishing industry; and an attempt has been made to obtain some information of the variations occurring throughout the year in the chemical composition and plankton content of the inshore waters of the Gold Coast Colony. As no suitable craft was available for going far out to sea, the samples were taken at a point about one and a half miles from the shore in a depth of eight fathoms of water off Accra, the capital of the Colony. Samples were taken each week (with one or two exceptions) from the beginning of June 1943 to the end of September 1944. One sample was taken for chemical examination and one for a rough examination of the quantity and general character of the plankton content; both samples were taken 5–6 feet below the surface. The temperature of the samples was taken at the time of sampling, and salinity, dissolved oxygen, and phosphate were estimated in the laboratory. These results are shown graphically in Figs. 1 and 2.

From Fig. 1 it will be seen that during this period the variation in temperature exceeded 10° C. The highest temperature recorded was 29·4° C. on May 13, 1944, and the lowest was 19° C. on August 3, 1943. The lowest temperature recorded in 1944 was 19·8° C. on August 18. The relatively sudden and wide variations in temperature which occur between June and October are presumably a causative factor in the seasonal nature of the fishing in the waters of the Colony. As might be expected, the figures for the salinity ($S^0/_{00}$) given in Fig. 1 do not, with one exception, show any wide variations; but there is a slight increase observed in August and September both in 1943 and 1944. The rather low salinities observed at the beginning of July 1943 occurred at times of heavy rain.

The one wide variation referred to above occurred at the end of January and the beginning of February 1944. At that time the salinity fell from 33·93 on January 25 to 30·05 on February 9, and then rose sharply again to 34·95 on February 22. This very sudden fall is difficult to explain. It occurred at a time when there was no rain in the Accra district or along the coast. At this time, however, there was a strong east-to-west current and the only reasonable assumption is that large volumes of water from the River Volta formed a surface current which flowed westward as far as Accra.

The figures for the dissolved oxygen shown in Fig. 2 are the amounts of oxygen expressed as the percentage saturation. The figures show a surprising consistency during the greater part of the year. From the middle of October 1943 to the middle of July 1944 the saturation never exceeded 100 per cent or fell below 94 per



Full line: temperature (°C.)
Broken line: salinity.

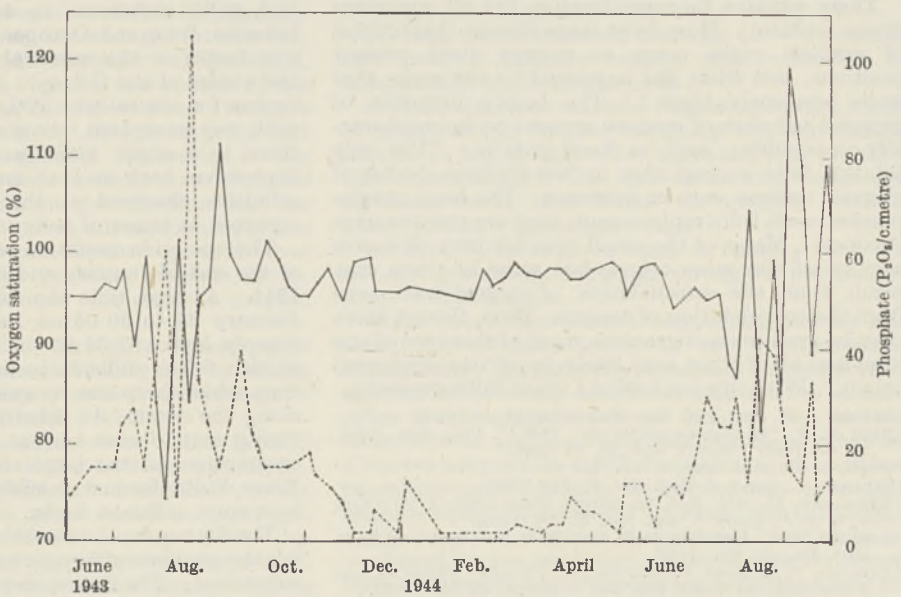
FIG. 1.

cent. The latter part of July, August and September brought wide variations both in 1943 and 1944.

The figures for the phosphate content given in Fig. 2 are the amounts of phosphate calculated as P_2O_5 per cubic metre. It will be observed that from the beginning of January to the end of March 1944 the amount of phosphate remained almost at zero, while July, August and September in both years saw moderately high values. The densities of the samples were determined at 80° F. (26·7° C.); the highest value was 1·0268 (80°/80°) on September 19 and 27, 1944, and the lowest was 1·0226 (80°/80°) on February 10, 1944.

As no trained marine biologist was available to undertake full examination of the plankton samples, their investigation was not so complete as could be desired; so only certain broad generalizations can be made. The vegetative plankton was found to consist of diatoms, chiefly *Chætoceros* spp., *Coscinodiscus* spp., and *Rhizosolenia* spp., and dinoflagellates such as *Ceratium* spp. and *Dinophysis* sp. The animal plankton consisted almost entirely of crustaceans and *Sagitta* sp. The crustaceans were mostly various species of copepods, but numbers of the larval forms of larger crustaceans were found. several species of echinoderm larvæ were also taken in the tow-net, and on one or two occasions fish eggs were seen.

It was found that the character of the plankton samples changed considerably during the period under review. In June 1943 the samples were moderate in quantity and were composed chiefly of copepods and *Sagitta* sp. In July, August, and part of September 1943, the samples consisted almost entirely of diatoms, chains of *Chætoceros* spp. being specially abundant. After the end of September, apart from a few *Coscinodiscus* spp., practically no diatoms were observed, the samples being composed of copepods and *Sagitta* sp. In January, February and March 1944 the samples were, generally, poor in quantity and were composed chiefly of copepods and a few *Sagitta* sp. In April and May the quantity was generally larger and the samples were again composed of copepods and *Sagitta* sp. with a number of larval medusæ. At the beginning of June, diatoms began to appear in some quantity, although the catch was still composed chiefly of copepods. Later on in the month *Coscinodiscus* sp. and *Ceratium* spp. were also present, again with a large number of copepods. In July the quantity of the samples was considerably larger, and by the end of that month there were only a few copepods present and the bulk of the catch was *Coscinodiscus* sp. and chains of *Chætoceros* spp. During this month, too, a considerable number of echino-



Full line: oxygen saturation.
Broken line: phosphate per cubic metre (uncorrected for salt error).

FIG. 2.

derm larvæ were observed. The character of the samples remained the same during the first part of August, but in addition some *Rhizosolenia* spp. (?) were observed. On August 16 a very unusual phenomenon was observed when taking the water sample. The sea was found to be a distinct chocolate-brown colour and very turbid. A sample was taken in a glass jar and the colour was seen to be due to vast numbers of a small greenish-brown organism just sufficiently large to be distinguished by the naked eye. Examination in the laboratory later on showed it to be a flagellated organism, which I was unable to identify. The plankton sample consisted almost entirely of masses of this organism. I do not know how far the coloration extended, but it was observed from aircraft for at least 70 miles along the coast. The phenomenon persisted for days, and when the next weekly sample was taken there were still masses of the organism in the plankton sample. During the first part of September *Coscinodiscus* sp. and *Chætoceros* spp. composed the bulk of the catch, and later on *Noctiluca* sp. (probably *N. scintillans*) predominated.

An examination of the data obtained from the samples appears to indicate that there is an influx of cold ocean water along the sea-board of the Colony during the months of July, August and September. This may be due to an upwelling of deep ocean water on to the continental shelf, or to cold ocean water from the South Atlantic Ocean finding its way into the current which flows for the greater part of the year from west to east along the sea-board of the Colony. It is probably not without significance that this influx of cold water, slightly more saline and richer in phosphate, coincides roughly with the main fishing season along the greater part of the coast of the Colony, when two species of *Sardinella*—*S. aurita* and *S. cameronensis*—are caught in large quantities.

It is hoped to continue and extend this work in the near future.

THE PUBLIC SCHOOLS OF BRITAIN

By the Rev. Canon SPENCER LEESON
Headmaster, Winchester College

THE public schools question has been somewhat in abeyance in recent months. Among the reasons for this is that the larger share of public attention in this province has been given to the Education Act, and the numerous administrative measures that are required to bring it into effective operation; and also that up to now the negotiations between the Ministry, on one hand, and the associations of governing bodies for boys' schools and girls' schools, the headmasters and headmistresses on the other, have been confined to scheme *A* of the Fleming Report, that is, the recommendations applying to what will be known in the future as direct-grant grammar schools. These negotiations are pretty well completed, and the revised regulations for direct-grant grammar schools have now been published. Discussions on scheme *B*, that is, those recommendations that affect mainly the independent boarding schools and day schools, are just beginning; and we may therefore expect a revival of public interest in the future of those schools.

The Fleming Committee is to be warmly congratulated on producing a unanimous report on so difficult and controversial a question; and its whole discussion of the matter and its recommendations are clearly based on a wide and deep knowledge of conditions prevailing in the schools, and the concrete problems that have to be solved. Various proposals were put before them for the future regulation of the public schools. One extreme view was that they should be abolished altogether, their endowments taken over and their buildings dedicated to other educational purposes, hostels, residential courses in adult education and so forth. It is not likely that this view will be supported in any responsible quarter. Another suggestion was that the schools should be kept in operation, but should be handed over to the State to be run as part of the State educational service, boys and girls being allocated to them by public authority, and the schools being brought under full public control. The third proposal is that put forward by the Fleming Committee, namely, that the schools should remain independent, although open to inspection by the Ministry of Education and accepting to membership of their governing bodies public representatives up to not more than one third of the total number; and that they should reserve each year 25 per cent of their admissions for boys and girls who have previously been educated at primary schools, the expense, as calculated on a fee to be agreed upon for each school between the schools and the Ministry, to be met from public funds in so far as the parents themselves are unable to pay the full cost. It is around these recommendations that, no doubt, the coming negotiations will centre; and we may hope that in a few months some measure of agreement will be reached. It is made clear in the report that the co-operation of the schools is to be voluntary from their side and that no compulsion should be applied to them.

I submit that in the settlement of this great national question we should endeavour to free ourselves from political preconceptions and prejudice on both sides. History shows that politics is no friend to education, and that where political considerations and especially party considerations are allowed to come in from either end, the work of the schools suffers. I suggest that we should put all this on one side and base ourselves on two propositions. The first is contained in section 76 of the Education Act, 1944: . . . "In the exercise and performance of all powers and duties conferred and imposed on them by this Act, the Minister and Local Education Authorities shall have regard to the general principle that, so far as is compatible with the provision of efficient instruction and training and the avoidance of unreasonable public expense, pupils are to be educated in accordance with the wishes of their parents". The second proposition is contained in the first recommendation on p. 100 of the Fleming Report . . . "that opportunities of education in the schools included in our terms of reference (*i.e.*, roughly speaking, the public schools), and in any such other schools as may be approved for the purpose by the Ministry of Education, be made available to boys and girls capable of profiting thereby, irrespective of the income of their parents". No considerations other than these have really any bearing on the matter. If it is argued that ex-primary pupils should be taken into the schools at public expense in order to preserve the latter from extinction, that argument has no validity; if the schools cannot stand on their own feet, they had much better disappear. On the

other side, if it is argued that this infiltration, as it is called, of boys of one class into schools up to now reserved for boys of other classes, will have the effect of de-classing them, as it were, and detaching them from their former political and social allegiance, that also has no validity. Both are good examples of the wrong kind of approach. The only sensible and natural approach is surely this : Are there any parents who want their children to have boarding school education ? If so, is it fair or right that they should be debarred from obtaining that education for their children because they cannot afford to pay the fees ? Clearly the answer to this second question must be : No. If the public schools have worked out an educational method and standard that parents believe to be valuable, ought access to those schools to be confined, as it is now, to exceptionally clever boys who win scholarships, and boys whose parents can afford to pay high fees ? Clearly, again, the answer must be : No. How, then, can we put matters right ? I suggest by the adoption of a double-pronged policy ; first that the State should provide boarding schools of its own, and power to do this is conferred upon the State by the Act ; and secondly, that the existing boarding schools should take post side-by-side with these schools that soon, we hope, will be created, making their contribution under proper conditions, but preserving their independence. This policy will give rein to the incontestable right of parents to decide within reasonable limits how their children shall be educated ; and it will at the same time enable the public schools to make their offer without forfeiting their independence.

It may be asserted, in reply : Why should the schools be allowed to retain their independence ? On that the schools are unanimous and emphatic. It is not in the public interest that all schools of every kind should be controlled by the State, and this principle is conceded by Parliament in the Act. It is not the business of the State to control all education because it is the State ; but rather to encourage good work wherever it is being done, and to supplement the existing provision where the latter cannot cover the ground. Spiritual and intellectual liberties of the highest significance for the welfare of Britain are involved in this ; and it is probable that if, as a condition of participating in this or any other scheme, the schools are asked to surrender their independence, they will have nothing further to do with the matter. They would, I believe, be unanimous in welcoming, as they are now under the Act required to accept, inspection by the Ministry, and personally I can see no objection to the inclusion of public representatives in the proportion suggested on the governing bodies. There, however, external supervision should stop.

There are a large number of details that will have to be worked out and which cannot, owing to limitations of space, be set out in this article—for example, the age of entry, methods of selection, the preparatory stage, assessment of parental and other contributions, agreement upon the standard fee, etc. Two general considerations can be urged at this stage. First, the schools are at present crowded to overflowing, the public demand for them is great ; and it may therefore take some time for them to work up to the full 25 per cent, if that recommendation should be accepted. Secondly, the report makes a fine offer to boys who have been previously educated at primary schools, and we may hope that nobody will seek to encroach upon or limit that offer to those boys. But it remains true that very little is offered to parents in straitened circumstances, poor professional men, who have not sent their children to primary schools. In the interests of justice and equality it is clear that later on, if not now, measures will have to be taken to open the door to the children of these parents also.

During the last six years many pages have been written on the public schools, some of the authors being inspired by an irrational adulation of everything they do, and others by an equally irrational detestation of them and all their works. It may be hoped that during the months that are approaching all that sort of nonsense may be forgotten. The plain fact is that the schools have something to offer ; and the plain question is, How can that be made use of in the interests of the nation as a whole ? The latest volume on the public schools is called "The Public Schools and the Nation", by Dr. A. B. Badger*. This is based on some careful research going back to the sixteenth century. The general tone of the book is critical, and no one who values the contribution made in the past, and to be made in the future, by the public schools will ever object to having their faults candidly pointed out. The general effect of the book is somewhat confusing, as it consists so largely of quotations from the opinions of other people, many of them expressed a number of years ago, and applying, therefore, to conditions which have long since ceased to exist in the schools. Readers will welcome Dr. Badger's compilation and be grateful to him for his research ; but the best of all guidance to future policy is to be found in personal, up-to-date, first-hand acquaintance with what the schools are and what they try to do.

* The Public Schools and the Nation. By Dr. Alfred B. Badger. Pp. 160. (London : Robert Hale, Ltd., 1944.) 8*s.* 6*d.* net.

OBITUARIES

Sir Duncan Wilson, C.V.O., C.B.E.

SIR DUNCAN WILSON who, until his resignation in 1940 was chief inspector of factories, died suddenly on March 2 in his seventieth year. On leaving Eton he entered Magdalen College, Oxford, where he took his degree with first-class honours in natural science, and although his life-work has mainly been in administration, yet his scientific training proved a very valuable asset.

His official career falls roughly into three main periods. For fourteen years from 1904 he was a factory inspector ; then came twelve years in which, as secretary, he organized the Industrial Fatigue (later Health) Research Board ; after which he returned to his old department, first as deputy and then as chief inspector of factories.

Perhaps the mid-period gave Sir Duncan the greatest opportunity to use his scientific knowledge and to express his individuality. The Industrial Fatigue Research Board was a very small organization, formed at the dissolution of the Health of Munition Workers' Committee at the end of the War of 1914–18, to apply the principles of physiology and psychology to research into industrial problems. In his first annual report published in 1920 he wrote, "The scientific study of the laws governing the healthy employment of the human mind and body in industry was strangely late in its development in this country,

although it was in Great Britain that the industrial revolution had its first beginnings and industrial development was most rapid". In his next report he introduced the same theme, "Industries for the most part are not yet fully alive to the importance of the human factor in production and to the still greater part this is destined to play in the future". It is partly due to the early work of Sir Duncan that these words are less true now.

In his early organization each investigator was responsible for a particular industry, and the investigators concerned themselves principally with hours of labour and the general environmental conditions likely to cause undue fatigue. As time went on investigators developed individual interests and worked along more specialized lines. As an organizer, Sir Duncan interfered as little as possible with his staff, although he was always willing to help where help was needed, either in making arrangements with a particular firm, or advising on the form of a report; and no small part of the work of the Industrial Health Research Board has been made possible by his unobtrusive but valuable help. By 1930 there had been published fifty-six reports dealing with hours of labour, lighting, heating and ventilation, vocational guidance, boredom, accidents, time and motion study.

There was an entire absence of 'red tape' in his dealings with his staff, and all, however junior, could have access to him. He had a remarkable poise of personality which made him at home with people of all ages and social class. He could without conscious effort talk equally easily to a factory worker or a duchess, to an industrial magnate or a humble apprentice, and to go round a factory with him was invariably a valuable experience. He was unusually scrupulous in giving credit to researchers and in acknowledging their work. He had many interests outside his work and was an excellent amateur musician.

Sir Duncan's official retirement was in name only, for he carried on numerous activities after the outbreak of war, serving as chairman of the National Industrial Electric Lighting Service and of the Home Office Committee on Factory Lighting, a subject that had always been of great interest to him. He will, however, always be affectionately remembered by his colleagues for his humanity.

Prof. Paul Bertrand

Son of the distinguished palæobotanist Charles Eugène Bertrand (1851–1917), Paul Bertrand, the report of whose death has recently reached Great Britain, followed up his father's work on fossil plants, and became a leader in palæobotanical research. He was professor of palæobotany in Lille until 1938, when he was appointed to the chair of comparative anatomy for the study of fossil plants at Paris. He died in Paris after a short illness aggravated by privation and anxiety on February 24, 1944.

Most of Bertrand's published work falls within the period 1910–39. His most important contributions to the literature of his subject fall into two groups. His work on the Carboniferous floras of the French coal-measures has proved indispensable to students of Carboniferous stratigraphy in Europe and America. His recognition and demonstration of stages or zones in the succession of vegetation in the Carboniferous which could be recognized and defined by their floristic composition will remain, just as the corresponding work by Kidston in Britain, a classic example of the application of palæobotanical research to geology. Their work has led up to more recent work by Dr. Dix in South Wales and by many workers in North America. As an accompaniment to this work he produced monographs of outstanding quality on the Pteridosperm genera *Alethopteris*, *Mariopteris* and *Neuropteris*.

The essence of all this research is contained in Bertrand's contributions to the *Comptes rendus* of the Congresses on Carboniferous Stratigraphy held in Heerlen in Holland in 1927 and 1935. On the botanical side, his work on Algæ (Botryococcaceæ) found as constituents of certain coals, and on the anatomy of Devonian and Carboniferous ferns, is of outstanding quality and importance. Here he ranks with Williamson, Scott, Kidston and Lang as an outstanding contributor to our knowledge of the anatomy of Devonian and Carboniferous plants.

Bertrand kept in touch with a wide circle of friends interested in palæobotanical work, and, with Mme. Bertrand, who survives him, regularly attended international meetings. Those who were privileged to know him will remember his quiet unassuming character, and his unfailing sympathy and interest in his friends' difficulties and problems. To know the Bertrands was to know what is best and most charming in the French character. His death causes an irreparable loss to many—especially to his younger colleagues, to whom he was unfailingly helpful.

John Walton.

Dr. Max Bergmann

Dr. Max Bergmann, the distinguished chemist, died in New York on November 7, 1944, at the age of fifty-eight. Dr. Bergmann, who was born in Fuerth, Bavaria, studied chemistry in Munich and received his Ph.D. degree in the University of Berlin in 1911. He then entered the laboratory of Emil Fischer, where he worked until the latter's death in 1919. In 1921 Bergmann became director of the Kaiser Wilhelm Institute for Leather Research in Dresden, a position which he held until 1934. Shortly after Hitler came to power, Bergmann, being a Jew, resigned his post and accepted the position of an associate member of the Rockefeller Institute for Medical Research in New York. He was appointed a member of the Institute in 1937 and occupied this position at the time of his death.

Bergmann's work up to the time when he left Germany followed fairly closely both in subject-matter and in his way of approach that of his great master, Emil Fischer. It was concerned, almost exclusively, with the organic chemistry of amino-acids and carbohydrates. Fischer had discovered a new class of sugar derivatives, the glycals, but Bergmann proved that the structure assigned to them was not correct. He showed that these compounds were not aldehydes as Fischer had assumed, and also demonstrated the presence and position of a double bond and established the size of the ring. Another field of sugar chemistry in which Bergmann made notable contributions was that of chitin and glucosamine. His isolation of the disaccharide, chitobiose, was contemporary with that of Zechmeister.

The main interest of Bergmann was, however, in amino-acids. He extended greatly our knowledge of the azlactones, the highly reactive unsaturated anhydrides formed from amino-acids; his last paper, which appeared after his death, was devoted to this

subject. He was interested in most aspects of the organic chemistry of amino-acids, and it is difficult to single out particular contributions. His work was distinguished by a real elegance in conception and great skill in execution. Thus, his model experiments on the formation of creatine from arginine anticipated by many years more recent work on the occurrence of this reaction in the living animal. Bergmann's papers covered the problems of acyl migration, racemization, reactions of β-hydroxy-α-amino-acids, unsaturated peptides, and many others. His crowning achievement during that period was, however, his novel and important general method of peptide synthesis. The classical methods of Fischer permitted only the preparation of peptides made from simple amino-acids. Bergmann's new method made use of N-carbobenzoxy derivatives of amino-acids; the acyl substituent protected the amino-group during the condensation and could afterwards be easily removed by catalytic reduction. This new method made possible the synthesis of almost any desired peptide.

Bergmann's work during his second, American, period was turning away from pure classical, organic chemistry, and more concerned with the structure and biochemistry of proteins. He showed for the first time that the pure crystalline, peptic and tryptic enzymes which had been prepared by Northrop and his school would act not only on proteins, as had been thought hitherto, but also on certain peptides. The work dealing with the substrate specificity of these enzymes was of much importance for our knowledge of enzymes and helped greatly towards a better understanding of the structure of proteins. Bergmann's work also extended to the proteinases of plants and those of animal tissues. Another field in which Bergmann made very important contributions was that of the analysis and isolation of amino-acids present in proteins; he discovered many specific precipitating agents for amino-acids and devised new and interesting methods of analysis. Together with Niemann he formulated the so-called 'frequency-law', which assumed that the different amino-acids in a protein molecule are present in certain restricted proportions. Although the exact quantitative relationships assumed may have to be modified, the emphasis on stoichiometric regularities has greatly stimulated analytical work and focused attention on the regularity of the internal architecture of protein molecules.

The loss of Dr. Bergmann will be felt by organic chemists and biochemists all over the world; he leaves a widow and two children. A. NEUBERGER.

NEWS and VIEWS

Glass Technology at Sheffield: Prof. W. E. S. Turner, O.B.E., F.R.S.

THE announcement that Prof. W. E. S. Turner is to retire from the chair of glass technology in the University of Sheffield, which he has held since 1920, comes as rather a shock. Prof. Turner's name has become so closely associated with the application of scientific principles to glass manufacture that it is hard to visualize the industry without this association. In 1914, Prof. Turner was responsible for the setting up of a Scientific Advisory Committee of the University of Sheffield to deal with technical problems arising in the local industries and, following on this work, was led to prepare a report on conditions in the glass industry. This report also made recommendations to the University Council, with the result that a Department of Glass Technology was set up in June 1915. This work was organized by Dr. Turner, as he then was, and in 1920 the Council converted this Department to a chair of the University. From that date to the present, Prof. Turner has made and established a name in connexion with the glass industry which will stand for all time.

Prof. Turner founded the Society of Glass Technology in 1916, and has been editor of the Society's journal throughout its existence. He has been president of the Society on two occasions, 1922–24 and 1937–38, and has acted as secretary for three long periods. Prof. Turner has also been instrumental in initiating international meetings between glass technologists in America, France, Belgium, Germany and Denmark, founding the International Congress on Glass, the first meeting of which was held in Milan in 1933. He was also responsible for instituting the Glass Convention, which brought together industrialists, administrators, commercial representatives and glass technologists. The teaching work of the Department under his guidance has been of such importance that many of his former students now occupy important positions throughout the industry. His researches cover the whole range of glass technology and scientific research into glass and related problems. There can be few instances where one man has become so closely identified with an industry and where, in the lifetime of one man, and to a great extent due to his efforts, that industry has developed from one depending almost entirely on craftsmanship to the position where scientific control and mechanized processes have been so fully established.

Dr. Harry Moore

DR. HARRY MOORE, who has been appointed by the Council of the University of Sheffield to succeed Prof. Turner on his retirement, will bring with him to the task the benefit of a broad academic training and research experience, coupled with exceptionally wide and specialized technological knowledge. After a distinguished student career at the Royal College of Science during 1904–7, followed by a year as a demonstrator in the Physics Department of the College, he was, in 1908, appointed lecturer in physics at King's College, London, a post which he held until 1915. While there he published in the *Philosophical Magazine*, the *Proceedings of the Royal Society* and the *Proceedings of the Physical Society* papers on the influence of X-rays on various substances. Another group of papers on X-rays appeared between 1924 and 1928 in the *British Journal of Radiology*. During 1915–19 he was busy in connexion with Ministry of Munitions training schemes, finally being transferred to the Ministry of Labour Training Department as chief technical officer for south-west England. In 1919 he was appointed assistant director of research of the British Scientific Instrument Research Association under Sir Herbert Jackson, and when Sir Herbert retired in 1933, Dr. Moore succeeded him. In 1937, Messrs. Pilkington Brothers decided to build and equip extensive research laboratories and invited

The vacancies advertised in these columns are available only to applicants to whom the Employment of Women (Control of Engagement) Orders, 1942-3, do not apply.

HERIOT-WATT COLLEGE EDINBURGH

PROFESSORSHIP OF MECHANICAL ENGINEERING

The Governors invite applications from British Subjects for the Professorship of Mechanical Engineering which will shortly become vacant owing to the retirement of Professor A. R. Horne, O.B.E., B.Sc., M.I.Mech.E., A.M.Inst.C.E., F.R.S.E. The Professor is Head of the Mechanical Engineering Department which includes Day and Evening Courses of study. Salary £1,000 by £50 to £1,200, plus War Bonus.

Applications may be submitted by suitably qualified persons now in H.M. Forces.

Further particulars may be obtained from the Principal at the College to whom application must be sent not later than May 14.

J. CAMERON SMAIL,
Principal.

HERIOT-WATT COLLEGE EDINBURGH

Lectureship in Mechanical Engineering

The Governors invite applications from British Subjects for Lectureship in Mechanical Engineering. Laboratory and Workshop experience are essential. Candidates will be placed on salary scale according to qualifications and experience.

Applications must be made, on forms to be obtained with full particulars from the College, not later than May 14th.

J. CAMERON SMAIL,
Principal.

DERBY TECHNICAL COLLEGE

NORMANTON ROAD, DERBY

Applications are invited for the post of Full-Time Lecturer in the Department of Natural Science. Candidates must have an Honours Degree in Zoology of a British University, industrial and/or research experience would be a recommendation.

Salary according to Burnham Scale. Application forms, to be returned by April 24th, and further particulars may be obtained from the undersigned.

W. ALFRED RICHARDSON,
Principal.

BIRKBECK COLLEGE

(University of London)
AUTUMN TERM BEGINS ON MONDAY, SEPTEMBER 24

Applications for admission from men and women who desire to read as part-time Internal Students of the University for degrees in the Faculties of Arts and Science, or for the Diplomas in Geography and Psychology, should be addressed to:

THE CLERK,
Birkbeck College, E.C.4.

THE WEST OF SCOTLAND AGRICULTURAL COLLEGE

The Governors invite applications for the post of Assistant Lecturer in Zoology, with special qualifications in Entomology or Helminthology.

Salary on the range £350-£450 (men) and £280-£360 (women), according to age, qualifications and experience, plus appropriate war bonus.

Particulars of the terms and conditions of appointment may be had from the subscriber, with whom applications are to be lodged not later than May 5, 1945.

A. J. WILSON,
Secretary.

Blythswood Square,
Glasgow.

UNIVERSITY OF OXFORD

LECTURESHIP IN DESIGN AND ANALYSIS OF SCIENTIFIC EXPERIMENT

Applications are invited for the above Lectureship and should reach the Registrar of the University by May 26, 1945. Tenable for five years. Stipend £600 per annum, plus bonus including children's allowances. The stipend will be included in a general revision of stipends now under consideration. Retiring age, 65. Further particulars may be obtained on application to the Registrar, University Registry, Oxford.

TYNDALL MINING RESEARCH STUDENTSHIP

It is proposed to make an appointment to the TYNDALL MINING RESEARCH STUDENTSHIP of the Royal Society which will fall vacant on June 1, 1945. This studentship is a part-time appointment to the value of £60 a year for the purpose of encouraging and furthering research in all matters pertaining to mining, including such questions as ventilation, temperature, disease incidental to miners and any other lines of scientific inquiry conducive to the improvement of mining and the lot of miners.

Candidates should submit a short statement giving age, qualifications, present position, a description of the proposed research, place of research and particulars of other grants and emoluments held. Applications should reach the Assistant Secretary of the Royal Society, Burlington House, London, W.1, not later than April 30, 1945.

BEDFORD COLLEGE FOR WOMEN

(University of London)

Regent's Park, N.W.1.

The Council of Bedford College invites applications for the post of Laboratory Assistant (man or woman) Grade I, in the Department of Zoology. Salary £4-£6 per week. Initial salary according to qualifications and experience. Applications, stating age, qualifications and experience to the Secretary.

BEDFORD COLLEGE FOR WOMEN

(University of London)

Regent's Park, N.W.1.

Wanted immediately LABORATORY APPRENTICE (boy or girl) in the Department of Botany. Initial salary 30/- per week. Applications to the Secretary.

BEDFORD COLLEGE FOR WOMEN

(University of London)

Wanted immediately LABORATORY APPRENTICE (boy or girl) in the Department of Zoology. Starting salary 30/- per week. Applications—The Secretary.

ROYAL HOLLOWAY COLLEGE

(University of London)

Appointment of a Lecturer in Zoology

The Governors invite applications for the above post, which is resident and open to women only. Applications are required not later than April 28, 1945. Full particulars may be obtained from the Principal, Royal Holloway College, Englefield Green, Surrey.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY

A Course of six lectures on Microscopy will be given in the Physics Department (Technical Optics Section), by B. K. Johnson, D.I.C., on Tuesdays and Thursdays at 4 p.m., commencing Tuesday, April 17, 1945.

A limited number can be taken for a practical course following the course of lectures. Application for admission should be made to the Registrar of the Imperial College, Prince Consort Road, S.W.7. Fee for lectures: £1. 1s., for practical £2. 2s.

UNIVERSITY OF MANCHESTER

I.C.I. RESEARCH FELLOWSHIPS

Applications are invited for Research Fellowships, normally of the value of £600 per annum founded by Imperial Chemical Industries, Ltd., tenable in the University and available for research in Chemistry, Physics and allied subjects. Applications should be received by April 30th.

Regulations governing the award of the Fellowships may be obtained from the Registrar, The University, Manchester, 13, to whom all applications should be sent.

UNIVERSITY OF LONDON

The Senate invite applications for the University Chair of Chemistry tenable at King's College (salary not less than £1,150). Applications must be received, not later than first post on May 18, 1945, by the Academic Registrar, University of London, Richmond College, Richmond, Surrey, from whom further particulars should be obtained.

UNIVERSITY OF SHEFFIELD

Lecturer in Electrical Engineering

The Council invite applications for appointment as Lecturer in Electrical Engineering. Qualifications in light-current engineering, particularly electronics, will be a recommendation. Salary £570 per annum with War-Time marriage and children allowance. Further particulars may be obtained from the undersigned, with whom applications should be lodged by April 30th.

A. W. CHAPMAN,
Registrar.

UNIVERSITY OF SHEFFIELD

Lecturer in Refractories in the Department of Metallurgy.

The Council invite applications for appointment as Lecturer in Refractories in the Department of Metallurgy. Salary up to £700 per annum, according to qualifications, with war-time marriage and children allowance. A candidate should possess qualifications in Physics, Physical Chemistry or Metallurgy, with appropriate research experience. Further particulars may be obtained from the undersigned, with whom applications should be lodged by May 14, 1945.

A. W. CHAPMAN,
Registrar.

The British Non-Ferrous Metals

Research Association offers Bursaries for two years to not less than two and not more than five university graduates in metallurgy, chemistry, physics or engineering, at the end of which the holder will be free to take a post in industry or to consider any offer of employment on the Association's staff which may be made. The value of the bursary will be not less than £225 during the first year and not less than £250 during the second, depending on age, qualifications and aptitude for the work. The Association's war bonus in force at the time will be added to this remuneration. Applications, giving full particulars of age, training, etc. should reach The Secretary, British Non-Ferrous Metals Research Association, 81-91 Euston Street, N.W.1, forthwith.

The British Cotton Industry Research

Association is planning to extend its research activities at the earliest opportunity and applications are now invited for posts on the research staff. Applicants should preferably be not more than about 35 years of age, possessing at least a good honours degree and trained in chemistry, physics, engineering physics or mathematics. Consideration will be given to applications from candidates who cannot be released immediately from their present posts.

Applications together with a statement of previous experience should be made to the Director of Research, Shirley Institute, Didsbury, Manchester, 20.

Institute of Physics, London. Applications

are invited for the post of Assistant Secretary from men with qualifications at least up to A.Inst.P. standard. Basic commencing salary up to £875 p.a. Superannuation additional. Applications from candidates who may be unable to take up their duties immediately will be considered. Further particulars from the Secretary, The Institute of Physics, at its emergency office, at The University, Reading, Berks, to whom applications should be submitted before April 28, 1945.

Wanted: Senior Research Officer for

new overseas organization investigating the field of the industrial diamond. Preferably Ph.D. with industrial research experience, capable of investigating the Chemical, Physical, and other properties of industrial diamonds. A knowledge of Metallurgy or Powder Metallurgy would be an asset.—Submit application, complete with details of training and experience with references, to Box 825, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Laboratory Instruments and Apparatus.

An old-established Company requires an Executive Assistant with experience of Chemical and other scientific apparatus, capable after some training of undertaking the organizing of sales. Applications from members of H.M. Forces will be welcomed.—Write, Box 3480, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Laboratory Outfit wanted by Con-

sultant Chemist, including Balance, Glassware, etc. Complete existing Laboratory considered. Pattison, Siddals, Derby. Tel. 45249.

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Dr. Moore to become the first director, a post which he still holds. He has served for some twenty-five years on committees of the British Standards Institution dealing with subjects related to instruments and to glasses for a variety of purposes; and since 1933 on the inter-departmental committee on optical glass set up by the three Service Departments. In April 1944 Dr. Moore was elected to the presidency of the Society of Glass Technology, and has been nominated for a second year of office. Dr. Moore, with his wise and genial personality and his wide experience of glass and its manifold applications, is an excellent choice for the variety of important activities centred in the work of the Department of Glass Technology of the University of Sheffield.

Fisheries Adviser at the Colonial Office: Mr. C. F. Hickling

THE Secretary of State for the Colonies has appointed Mr. C. F. Hickling to be his fisheries adviser. This is the first time that the position has been filled on a permanent and full-time basis, Mr. Hickling's predecessor, Dr. E. S. Russell, having acted in a part-time capacity during a period of approximately two years. The possibilities for development and research in Colonial fisheries are very considerable, and the post of fisheries adviser is one of great opportunity. Mr. Hickling, who will take up his duties immediately, will be assisted and supported in his task by the Colonial Fisheries Advisory Committee which was appointed in 1943.

After taking his degree at Cambridge, Mr. Hickling engaged in postgraduate research at the Marine Biological Laboratory, Plymouth, and the Department of Oceanography, University of Liverpool, and in 1927 was appointed to the fishery research staff of the Ministry of Agriculture and Fisheries, in which he rose to the rank of senior naturalist. His work as a fishery investigator was of a high order; he published in several parts an excellent monograph on the hake and the hake fisheries, on which he became an acknowledged authority, together with many other papers on cognate subjects. His Buckland Lectures on the hake were published in 1934. During the War he has been acting as port fishery captain at Milford Haven with conspicuous success, and he has also found time to make a statistical study of the effects of the War upon the hake stocks, as yet unpublished.

Colonial Medical Research Committee

THE Secretary of State for the Colonies and the Medical Research Council have jointly created a Colonial Medical Research Committee to advise them on medical research for the benefit of Colonial territories. It is constituted as follows: Sir Edward Mellanby, secretary of the Medical Research Council (chairman); Colonel J. S. K. Boyd; Prof. P. A. Buxton, professor of entomology, London School of Hygiene and Tropical Medicine; Dr. A. N. Drury, director of the Lister Institute of Preventive Medicine; Brigadier N. Hamilton Fairley; Dr. W. H. Kauntze, chief medical adviser to the Secretary of State for the Colonies; Prof. B. G. Maegraith, professor of tropical medicine at the Liverpool School of Tropical Medicine; Dr. B. S. Platt, director of the Human Nutrition Research Unit, Medical Research Council; and Major-General Sir John Taylor. The secretary of the Committee is Dr. F. Hawking, of the National Institute for Medical Research, London, N.W.3.

Restoration of Pulkovo and Kiev Observatories

A FIVE-YEAR plan for rebuilding the famous observatory at Pulkovo on the outskirts of Leningrad is announced by the Academy of Sciences of the U.S.S.R. The main building is to be restored as it was originally, and such of the valuable equipment and instruments as were removed to safety before the Germans began the bombardment of the besieged city will be installed again. The Observatory was completely destroyed, and the cost of reinstatement is estimated as 137 million roubles. The world-renowned library could not be removed in time, and many irreplaceable books and manuscripts are lost to posterity. Adequate provision to restock the library includes the earmarking of 200,000 dollars for purchases abroad. Plans for work in the future suggest that the character of the institution is not to be changed: both fundamental astronomical work and astrophysical researches will be undertaken.

At Kiev, where less damage was done, work is so far advanced that this year's centenary of the foundation of the Observatory should see the whole of the staff back at work in a reconstructed establishment. With more warning of what was coming than their Pulkovo colleagues, the Ukrainian astronomers were able to transport most of the instrumental equipment to Sverdlovsk, 3,000 km. to the east, where they were given refuge during the occupation. On their return they found the observatory buildings empty, plundered and partly ruined by the fleeing Nazi army. Rebuilding has proceeded at such a speed, however, that new pavilions already house the 257-mm. refractor and the 120-mm. meridian circle, and regular observations and instruction have started again. Extensions on which work has already begun include a building for a proposed big modern refractor, an astrophysical laboratory and a deep basement for seismic work.

Technical Education in Scotland

SCOTLAND, a country that has long been education-conscious, is fully alive to the importance of technical education in modern social life, and the Interim Report on Technical Education recently issued by the Special Committee of the Advisory Council on Education in Scotland (H.M. Stationery Office, Edinburgh, 3*d*.) advocates national planning on an extensive scale in order to bring training facilities within the reach of all. The core of the planning consists in the proposed establishment of a National Advisory Council for Technical Education, and four regional advisory councils (with a fifth for the Highlands, if necessary), all fully representative of industrial, commercial and educational interests, in order to survey both national and local requirements and to co-ordinate development schemes. The needs of part-time as well as full-time students have been considered in connexion with the organization of central institutions and local technical colleges, the former capable of dealing with work of the most advanced type and in some cases performing the functions of peak institutions for specialized subjects; technical instruction is also envisaged in the new colleges for compulsory further education of young persons and in voluntary day and evening classes where technical colleges cannot be established. It is realized that the new proposals will involve heavy financial commitments, and the National Council would therefore be required to make recommendations to the Secretary of State as to expenditure that is desirable. The proposals in the report are on a bold scale and well

calculated to produce a system of technical education to match the great literary and academic achievements of Scotland, which have perhaps in the past tended to obscure the activities of the technician, the artisan and the craftsman.

A National Health Service

IN "Health Abounding", issued by the Social Credit Party, 2 Fitzroy Street, London, W.1, Dr. A. T. Westlake describes the aims of the health service which is planned by the Social Credit Party. Dr. Westlake begins with some telling remarks about our existing health services and about the Government's proposals for a national health service. Our existing health services are complex and confused, and we fail to apply the knowledge that we possess. Health is largely dependent on our ability to pay for it, in spite of numerous charities and the altruism of the medical profession. Our existing health organization has, Dr. Westlake thinks, produced a magnificent service; but it contains fatal flaws, the most glaring of which is the making of a living out of ill-health. The Government's proposals for a national health scheme and the Beveridge proposals have brought matters to a head. All seem to be agreed that the future medical service will be a complete and comprehensive one covering everybody, but the problem is how best to create it. The Medical Practitioners' Union, the Socialist Medical Association and several other bodies advocate a State Medical Service; the British Medical Association seeks a compromise between the old system and the new proposals. A State medical service under present conditions can only mean, Dr. Westlake argues, rigid control of both medical man and patient, with strict certification. The Government's White Paper is not a health scheme, but a medical and sickness service; it is not a free service, for it is to be paid for by taxation, rates and social insurance. The only basis upon which can we have a free State medical service which leaves the medical man a free agent is, Dr. Westlake thinks, the Social Credit System.

The two main objects of this health service would be the health of the community organized into the cure, annihilation and prevention of disease and the promotion and maintenance of health; and the well-being and skill of all those who work in the health service. Curative work will for some time engage most of its attention, because of the gigantic proportions of the disease problem. No one is likely to object to Dr. Westlake's excellent suggestions under this heading. He would treat the mind as well as the body, deal drastically with the patent medicine racket and create real health centres which would cater primarily for the healthy and only secondarily for the diseased, for whom curative centres would be provided. Dr. Westlake here draws much on the experience of the Peckham Health Centre, which has provided valuable information. Prevention of disease depends on the abolition of poverty and on proper feeding, proper housing and elimination of industrial over-fatigue. These are the problems of social medicine, which is vitally important. Problems of immunization and health education are also discussed. In his discussion of health, Dr. Westlake again refers to the work of the Peckham Health Centre. Not everyone will agree with the development of this section of the pamphlet, or with Dr. Westlake's conception of a medical guild for the promotion of health and well-being. The General Medical Council exists for the protection, not of the medical profession, but of the public. Dr. Westlake would add to its functions the welfare and interests of the medical men also. Further sections of his pamphlet deal with administration, finance, hospitals and other details.

The Case for 'Planning'

THERE pamphlets issued by the Cheam Architectural Press (price 6*d*. each) in "The Planning Bogies" series are too good to be popular. Those who dislike Prof. H. J. Laski are unlikely to be pleased with the way in which in "Will Planning Restrict Freedom ?" he disposes of the bogie of bureaucracy, and the more ardent planners may be restive under his trenchant delineation of the conditions which planning machinery must serve in a democracy—his insistence on the participation of the ordinary citizen is, moreover, reflected in the other pamphlets. Mr. E. S. Watkins in "How Will Planning Affect Land Ownership ?" deals with nationalization; but the pamphlet also gives an admirably lucid explanation of the existing land ownership system in Britain and of proposals for reform as contained in the Uthwatt Report and elsewhere. The broad objectives of land control—to ensure both the best economic and the best social use of our land and resources—are well stated, and also the basic requirements of control; they lead to concrete suggestions as to the composition and areas of planning authorities and amendments to the Town and Country Planning Act, which would transfer the responsibility for planning from the existing local government authorities to *ad hoc* area planning committees.

Mr. E. F. Schumacher, in examining the question "What Will Planning Mean in Terms of Money ?", discusses first the case for physical planning; he believes that, when the social costs of unplanned development are taken into account, the question becomes rather whether we can afford to do without planning. Emphasizing the growing divergence between private and social costs, he examines the case for housing in further detail, and argues that physical planning is the pre-condition for the successful pursuit of a housing programme such as the Government is preparing to inaugurate. Without it a steady effective demand cannot be maintained, the programme will be wasteful and head for an early collapse.

New Electron Microscope for Canada

THE National Research Council of Canada announces the installation of the latest type of electron microscope in its Ottawa laboratories. This instrument and one developed in the Physics Department of the University of Toronto are the first electron microscopes to be used in Canada. A third microscope will be installed shortly at McGill University in Montreal. Plans to purchase this modern research instrument were made a year ago when the Council sent two physicists to the United States to study the available types. After the new R.C.A. Universal model was selected, priority application was made to the United States War Production Board, which scheduled delivery for January 1945. The Division of Physics and Electrical Engineering has provided laboratory space for the microscope and assigned a physicist in the Radiology Section to take charge of it. It is hoped to make this new electron microscope as widely available in Canada as possible to all Government laboratories and to those industries having suitable problems.

Recent Earthquakes Recorded in the British Isles

The earthquake widely noted in Britain on December 30, 1944, was recorded at Kew. From a preliminary reading of the record, it appears to have registered first at 00h. 36m. 14s. G.M.T. from an epicentral distance of 300 km. This would make the initial time of the shock 00h. 35m. 35s. G.M.T. Four strong shocks were recorded at Kew between January 9 and February 13, 1945. The strongest was on February 10, when an earthquake beginning in the region of Japan attained a ground amplitude of 145 μ at Kew. Mr. E. W. Pollard recorded two strong shocks on January 12 and 18, and earthquakes or tremors on February 10, 13, 17, 18 and 26 at his observatory at Binstead, Isle of Wight. The United States Coast and Geodetic Survey determined the epicentre of the earthquake of January 1, 1945, to have been near Baffin Bay.

War and Infectious Diseases

At a Chadwick Lecture on this subject delivered on February 20 at the Royal Society of Tropical Medicine and Hygiene, Dr. J. D. Rolleston discussed the various acute infectious diseases in relation to war in the following alphabetical order: cerebrospinal fever, diphtheria, dysentery, enteric fever, infectious hepatitis, malaria, measles, mumps, scarlet fever, small-pox, streptococcal infections, typhus fever and war wounds. Chronic infections, particularly tuberculosis and syphilis, were not considered. Comparative novelties mentioned in the lecture included diphtheria of the skin, infective hepatitis, the striking decline in the incidence and mortality of enteric fever, and the introduction of new specific remedies, of which the most valuable were penicillin for war wounds, sulphaguanidine for dysentery and atebrin for malaria.

Poliomyelitis Epidemic in America

According to Mr. B. O. Connon, president of the National Foundation for Infantile Paralysis (*J. Roy. Inst. Pub. Health and Hyg.*, Feb.), the 1944 epidemic in the United States has been the second worst in the recorded history of the disease. The seven States most severely menaced are New York, North Carolina, Pennsylvania, New Jersey, Virginia, Ohio and Kentucky. The peak of the epidemic was reached in the week ending September 2, when 1,683 cases were reported.

Colonial Office Appointments

The following appointments have recently been made in the Colonial Services: D. P. Pielou, to be entomologist, Northern Rhodesia; E. G. A. Benson, agricultural superintendent, British Guiana, to be agricultural officer, Trinidad; J. D. Brown, senior agricultural officer, Nigeria, to be principal agricultural officer, Nigeria; M. A. G. Hanschell, agricultural superintendent, British Guiana, to be agricultural officer, Sierra Leone; L. P. Henderson, agricultural officer, Nigeria, to be senior agricultural officer, Nigeria; A. Pitcairn, assistant director of agriculture, Cyprus, to be senior agricultural officer (supernumerary), Tanganyika; F. E. V. Smith, principal assistant secretary (Development Branch), Nigeria, to be development secretary, Nigeria; C. B. Taylor, agricultural officer, Nigeria, to be senior agricultural officer, Nigeria; D. H. Urquhart, assistant director of agriculture, Nigeria, to be director of agriculture, Gold Coast; R. G. M. Willan, assistant conservator of forests, Cyprus, to be assistant conservator of forests, Nyasaland; E. D. Fort, surveyor, Gold Coast, to be senior surveyor, Gold Coast.

Prizes for Scientific Instrument Manufacture

Mr. W. Bowen, governing director of the Bowen Instrument Co., Ltd., Cables and Plastics, Ltd., and Bowen Research, has presented to the Scientific Instrument Manufacturers' Association a substantial capital sum, the income of which he wishes to be devoted towards the encouragement and development of invention, design, research, processes and manufacturing technique in the scientific instrument manufacturing industry. The Council of the Association has accordingly drawn up a deed of trust under which the income from the fund is to be devoted each year to prizes to be awarded to the employees of members submitting papers fulfilling the objects of the trust. For the current year the Council has decided to award five prizes to the value of £25 each for (*a*) a new invention; (*b*) an improvement of design; (*c*) an improvement in manufacturing technique; (*d*) a new development or new process arising from research; and a list of topics defining the subjects or instruments admissible has been drawn up. Candidates should furnish a short description of one of the above subjects not exceeding 3,000 words with relevant sketches or diagrams, and they must be employees of members of the Association. All papers must be submitted to the secretaries of the Association, Messrs. Binder, Hamlyn and Co., River Plate House, 12–13 South Place, London, E.C.2, not later than December 31, 1945.

Announcements

Dr. N. Feather, lecturer in physics in the University of Cambridge, has been appointed professor of natural philosophy in the University of Edinburgh, in succession to the late Prof. C. G. Barkla.

Dr. L. C. Burrill has been appointed professor of naval architecture at King's College, Newcastle-upon-Tyne, as from October 1, 1945. Dr. Burrill is thirty-nine years of age. He has had a wide practical experience of naval architecture with Messrs. Swan Hunter and Wigham Richardson, Ltd. (1929–34), and the Manganese Bronze and Brass Co., Ltd., where he has held the position of naval architect since 1936. In addition to extensive research resulting in the recent award of the degrees of M.Sc. and Ph.D. in naval architecture, he also lectured at the Rutherford Technical College, Newcastle-upon-Tyne, for three years.

Messrs. Power Jets (Research and Development), Ltd., Whetstone, Leicester, have formed a Trade Catalogue Section in their Whetstone Library. Firms interested and associated in the production of machine tools, factory plant and equipment, physical and chemical laboratory equipment, electrical equipment, switch gear, motors, transformers, generators, etc., hydraulic pumps, air compressors, etc., who are willing to deposit a copy of their latest catalogues with Messrs. Power Jets (Research and Development), Ltd., are asked to send copies of their publications to the Librarian, Power Jets (Research and Development), Ltd., Whetstone, Leicester, for inclusion in the Library.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Terminology of Interpenetrating Twins in α-Quartz

AMONG those concerned with piezo-electric applications, it would appear that there is some confusion in the terminology for describing the interpenetrating twins which occur in α-quartz. For piezo-electric purposes, the highest quality Brazilian quartz is normally used, and there are three types of twinning of importance. These are: type 1, the rotational (Dauphiné) twin; type 2, the reflexion (Brazilian) twin; and type 3, a compound twin which can be regarded as a combination of types 1 and 2. Quartz technologists have their own terms for these twins; thus the first type is termed an 'electrical twin'; the other two types are broadly spoken of as 'optical twins', but their more exact descriptions are not well established.

While it has been customary to term the second type an optical twin and the third type a combined electrical and optical twin (compound optical twin), this nomenclature is sometimes, and it is thought incorrectly, reversed.

a. Type 1. Electrical twin (Dauphiné) — *b*. Type 2. Optical twin (Brazilian) — *c*. Type 3. Compound optica twin.

The accompanying illustrations show sections perpendicular to the trigonal (optic) axis in quartz crystals twinned respectively in each of the three ways. For clarity the sections are drawn as regular hexagons, the parent crystal completely enclosing the twinned areas (shaded hexagons). In practice, the twinning is usually irregular and often extends inwards from the outside of the crystal, but the diagrams retain the fundamental relationships, such as crystallographic orientation and electrical polarity. In each instance, optical activity is indicated by an arrow curled in the sense of rotation of plane-polarized light looking along the optic axis towards the source. Also, the parent crystal is chosen to be left-handed according to this convention. In denoting electrical polarity, the untwinned and twinned portions of the crystal are considered separately. Then the polarities marked at the vertices of the hexagons show the signs of the piezo-electric charges which would be produced at the prism edges on compression of the corresponding diameter. Finally, the lettering indicates the type of rhombohedral face occurring above each prism face, as represented by the sides of the hexagons. *R* and *r* indicate what are termed mineralogically the positive and negative rhombohedral faces respectively.

In all three types of twin, the optic axis is the twin axis. The rotational twin (Type 1) corresponds to a rotation of 60° about the optic axis without change of optical sense. Positive and negative rhombohedra are thus brought into coincidence, that is, *r*-faces of the twinned portion become parallel to *R*-faces of the parent crystal and vice versa. Also the sense of polarity of the twinned material is reversed with respect to that of the parent crystal. That is, the crystal as a whole is elastically and electrically inhomogeneous, but optically it is homogeneous. It is therefore appropriate to term this an electrical twin, and obviously this type of twin cannot be detected by direct optical means.

The reflexion twin (Type 2) corresponds to a reversal in the sense of the screw about the optic axis, without any rotation about this axis. That is, the sense of optical activity of the twinned portion is reversed whereas its orientation remains uniform with the rest of the crystal. The crystal is elastically homogeneous but optically inhomogeneous, and because of the reversal of the screw axis the twinned portion is of opposite electrical polarity. It should be noted that the cause of this reversed polarity is unrelated to electrical twinning as described above. This type of twin should be regarded as a purely optical twin, but confusion can arise because of the accompanying electrical inhomogeneity. If the crystal is described as a combined electrical and optical twin it might be thought that the reference was to a combined Dauphiné and Brazilian twin, which is incorrect.

The other twin (Type 3) corresponds to a reversal in the sense of the screw axis together with a rotation through 60° about this axis. That is, it can be regarded as a combination of the first two types of twin. The crystal is both elastically and optically inhomogeneous, but there is no reversal in the electrical polarity of the twinned portion. This type of compound twin is comparatively rare.

It would seem, therefore, that the following terminology should be adopted among those using quartz for piezo-electric purposes. Type 1 should continue to be termed 'electrical twinning'. Type 2 should be termed 'optical twinning', or 'simple optical twinning' where there is any risk of ambiguity. Finally, type 3 should be termed 'compound optical twinning'.

L. A. THOMAS.

Research Laboratories,
General Electric Co. Ltd.,
Wembley. Feb. 5.

Mechanism of the Oxidation of Coal

IT is well understood that the mechanisms of the oxidation of oils[1], the curing of rubber[2], the polymerization of unsaturated compounds[3], the overall combustion of higher hydrocarbons[4], as well as of certain biological processes[5], involve the formation of peroxidic bodies sometimes initiating chain reactions. Little attention has been directed hitherto to the possible role of such bodies in processes concerned with the solid phase.

The importance of the spontaneous oxidation of coal needs no emphasis; apart from fire risk, weathered coals may lose up to 15 per cent in calorific value[6], and the coking property of gas-making coals may be destroyed. There have been occasional suggestions in the literature that the initial oxidation may involve peroxidation[7], but so far as we are aware, no serious attempt has been made to investigate the matter. Recently we have adapted Yule and Wilson's method of estimating peroxygen[8], for the purpose of studying the behaviour of typical coals during oxidation; and the results have proved informative.

At room temperature, finely divided fresh coal accumulates peroxygen on exposure to the atmosphere, a maximum content being reached after several weeks; this may amount to 60×10^{-5} gm. per gm. of coal. At higher temperatures its rate of formation progressively increases, but above 80° C. the maximum ultimate content falls owing to decreasing stability. Experiments with some six coals have shown known ease of weathering to fall into line with degree of peroxidation.

If previously exposed coal be heated above 80° C. in an inert atmosphere, the breakdown of peroxygen can readily be followed. Further, whereas a suitable finely ground fresh coal will ignite spontaneously in oxygen if rapidly raised to a temperature of *c.* 135° C., a similar specimen, if subjected to such a preheat treatment, will not ignite.

It is well known that the attainment of a temperature of 85° C. in stored coal is dangerous; above it, oxidation becomes autogenous and there is serious risk of fire[9]. In our experience the oxidation mechanism changes at about this temperature. Below it, a relatively high concentration of peroxygen is formed, little oxygen entering into the coal substance and carbon monoxide preponderating in the gaseous products. Above it, the peroxygen breaks down rapidly, oxygen enters the coal substance and carbon dioxide preponderates in the gaseous products.

We are of the opinion that the peroxide material on decomposition opens the structure for further oxygen attack; and its rate of formation and subsequent breakdown may be taken as an index of the speed of overall oxidation in the temperature range in question. How far peroxidation is a surface effect, and how far an attack on specific chemical structures are matters for further investigation; the method has shown that certain carbons have the ability to form peroxygen[10].

This investigation has been carried out during the tenure by one of us (R. E. J.) of the Institution of Gas Engineers Research Fellowship.

R. E. JONES.
D. T. A. TOWNEND.
Dept. of Coal Gas and Fuel Industries,
University of Leeds. Feb. 12.

[1] Denison, *Ind. Eng. Chem.*, 36, 477 (1944).
[2] Farmer, *J. Chem. Soc.*, 125 (1943).
[3] Moureu and Dufraise, *Bull. Soc. Ind. Nat.*, 107 (1934).
[4] For example, Egerton and collaborators, *Phil. Trans. Roy. Soc.*, A, 234, 433 (1935).
[5] Rieche, *Z. ang. Chem.*, 45, 441 (1932).
[6] Beagle, *Ind. Eng. Chem.*, 17, 123 (1925).
[7] Porter and Ralston, *Bur. Mines. Tech. Paper*, 65 (1914). Bunte and Brückner, *Z. ang. Chem.*, 47, 84 (1934).
[8] Yule and Wilson, *Ind. Eng. Chem.*, 23, 1254 (1931).
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[10] Lamb and Elder, *J. Amer. Chem. Soc.*, 53, 157 (1931). King, *J. Chem. Soc.*, 842 (1933).

Phase-retarding Areas

THE phase retardation provided by evaporated fluoride films on transparent plates, suggested by E. H. Linfoot[1] as being of possible use in phase contrast microscopy, finds an important application in interferometry, where the phase-retarding areas have to be of much larger dimensions than are involved in phase contrast microscopy or applications of the Zernike test. It forms the basis of a method, developed here some time ago, of distinguishing between under- and over-correction of the aberrations corresponding to the pattern of interference fringes observed while using the Hilger lens-testing interferometer.

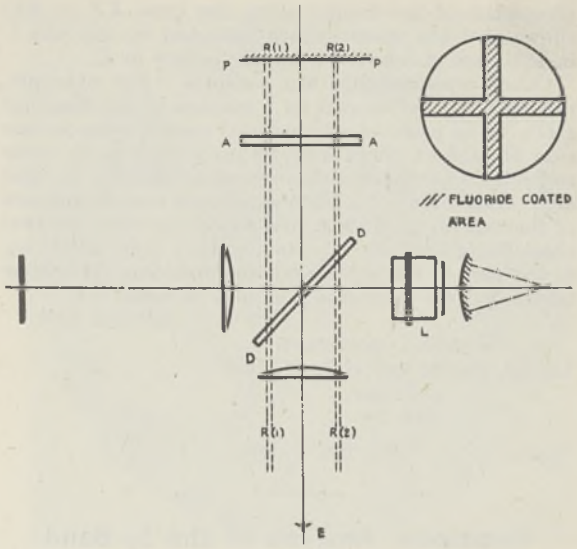
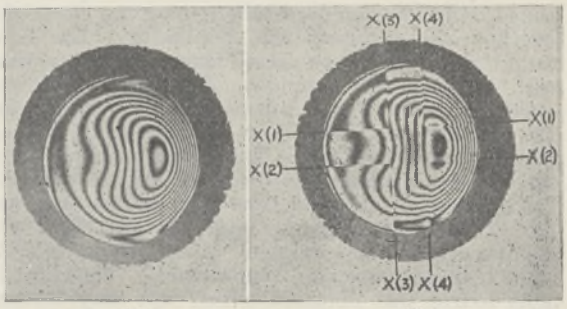


Fig. 1.

Where visual use alone is of importance, the sign of the wave deformation impressed by the lens L in Fig. 1, relative to the plane wave reflected by PP, is readily obtained by exerting a gentle pull on the cables $R1$ or $R2$ controlling the to-and-fro movement of PP. When a photographic record of the performance of a model lens is required, this method is not available. We have therefore inserted at AA, as shown, a plane parallel plate bearing on one face a cruciform fluoride-coated area (see inset diagram). A suitable film thickness may be deposited by continuing the evaporation for a little more than twice as long as the normal evaporating time for producing a non-reflecting film. Due to the double passage of the light through the plate AA, such a fluoride film impresses upon the light passing through it a phase retardation of approximately $\lambda/4$ relative to light transmitted by the uncoated areas. As a result, the fringes seen are displaced by quarter of a fringe where they are crossed by the fluoride-bearing area, the displacement being in an inwards direction when the wave-front distorted by passage through the lens L is concave towards the eye at E, and in an outwards direction when the wave-front is convex towards the eye. Typical examples of interferograms are shown in Fig. 2, at (*a*) without the fluoride-coated plate, and (*b*) with the plate in position. The inward dis-



(*a*) (*b*)

Fig. 2.

placement of the fringes along the lines XX in 2(*b*) shows that the wave surface distorted by the lens L in this case is concave towards the eye at E.

Other arrangements are possible. For example, the film may be formed on a surface of the diagonal DD; or in place of a cruciform coated area on one side of a plate, there may be used what is, in some respects, a preferable arrangement, namely, a clear area on each side of a plate carrying a normal amount of fluoride to produce a non-reflecting film, the two areas being similarly situated, so that light travelling in the arm of the interferometer including PP either traverses four thicknesses of film or none.

ARTHUR COX.

Research Department,
Taylor, Taylor and Hobson, Ltd.,
Leicester.
Jan. 30.

[1] Linfoot, E. H., *Nature*, 155, 76 (1945).

Rotational Analysis of the S_2 Band Spectrum

THE most complete vibrational analysis of the S_2 bands lying between λ2300 and 6200 A. has been given by Fowler and Vaidya[1]. They agree with the perturbations of the $\Delta G'$ values found by Christy and Naudé[2].

This irregular behaviour of the $\Delta G'$ values of the S_2 molecule no doubt complicates the rotational structure of the bands considerably. Olsson[3], however, seems to have succeeded in obtaining a satisfactory rotational analysis of the (3,2), (2,2), (3,3), (2,3), (1,3), (2,4) and (1,4) S_2 bands in absorption. It appeared to be of great value to verify Olsson's analysis by analysing the S_2 band spectrum obtained in emission. Seeing that it is possible to carry out the analysis with greater accuracy in emission, it was hoped to obtain more accurate information about the observed perturbations of the $\Delta G'$ values.

The S_2 bands lying between λ440 and 4950 A. have been photographed in the fourth order, and the bands lying between 4950 and 6200 A. have been photographed in the third order of the 21-ft. Gale concave grating mounted according to Paschen in this Institute. The dispersion obtained amounted to about 0·6 A. per mm. in the fourth order and to about 0·8 A. per mm. in the third order. The positive column of an inverted Π-tube constructed of 'Pyrex' glass and fitted with large cylindrical electrodes was used as light source. The sulphur was purified by slowly redistilling flowers of sulphur four times *in vacuo* from one 'Pyrex' vessel to the next by means of an electrical oven. The final 'Pyrex' recipient was sealed on to the capillary tube joining the electrodes of the Π-tube during the distillation. The light from the capillary tube passed through a quartz tube with sealed-in clear window. The quartz tube was sealed on to the 'Pyrex' tube with white sealing wax. The window was kept clear by constantly heating it with a small gas flame. The 'Pyrex' tube was first evacuated to a pressure of about 10^{-5} mm. of mercury. The sulphur in the side tube was heated to about 170° C. The discharge between the electrodes was maintained in pure sulphur vapour by a 5-kVA. 220–12,000-volt step-up transformer. Thus an S_2 light source was obtained which was very intense in the capillary tube and which could be photographed end-on through the quartz window.

The (1,14) band with its head at 4433·6 A.; (1,15), at 4563·2 A.; (2,16), at 4610·2 A.; (2,17), at 4747·6 A.; (3,17), at 4651·3 A.; (3,18), at 4790·8 A.; and the (3,19), at 4937·2 A. were photographed in the fourth order of the grating. The iron arc was used to supply the comparison spectrum. Using Eastman 33 plates, the exposure time required for all the bands except the (3,19) band was about two hours with a current of 18 amp. passing through the primary of the transformer. The (3,19) band required an exposure time of about twenty hours on Eastman IIIF plates.

The plates were measured correct to 0·001 mm. on a large Abbé-type comparator built in our Institute. The wave-lengths of the iron lines were obtained from Harrison's M.I.T. Wave-length Tables. The wave-lengths of the sulphur band lines were converted to wave-numbers *in vacuo* by using Kayser's "Tabelle der Schwingungszahlen".

Practically all the stronger lines of favourably situated bands, such as the (3,17) and (3,18) bands, could be accounted for by six branches. These six branches could be identified as R_1, R_2, R_3, P_1, P_2 and P_3 branches corresponding to a $^3\Sigma_u^- \rightarrow {}^3\Sigma_g^-$ transition.

The Δ_2F_1 values of the $v' = 1$, 2 and 3 vibrational states were found to agree within experimental error with those computed from the wave-numbers of the branches observed by Olsson. From the agreement of the Δ_2F_1 values obtained in the present analysis in emission, it became clear that an accuracy up to one in two million had been reached, and that the accuracy was greater than that obtained by Olsson in absorption.

The values of B'_v and B''_v could be obtained graphically from the $\Delta_2F'_2$ and $\Delta_2F''_2$ quantities of the various states and thus B_e and r_e could be found. These values are given in the accompanying table.

v''	B''_v	
27	0·2503 ± 0·0001	(Naudé)
25	0·2539	,, ,,
24	0·2556	,, ,,
23	0·2568	,, ,,
22	0·2589	,, ,,
19	0·2633	,, ,,
18	0·2651	,, ,,
17	0·2666 ± 0·0002	,,
16	0·2681 ± 0·0001	,,
15	0·2700	,, ,,
14	0·2716	,, ,,
8	0·2819 ± 0·0002	(Wilson)
7	0·2834	,, ,,
4	0·2883	,, (Olsson)
3	0·2896	,,
2	0·2915 ± 0·0001	,,

v'	B'_v	
7	0·2085 ± 0·0002	(Naudé)
6	0·2102 ± 0·0001	,,
5	0·2102	,, ,,
4	0·2150	,, ,,
3	0·2129	,, ,,
	0·2136	(Olsson replotted)
2	0·2175 ± 0·001	(Naudé)
	0·2177	(Olsson replotted)
1	0·2205 ± 0·0001	(Naudé)
	0·2200	(Olsson replotted)
0	0·221 ± 0·001	(Wilson)

B''_0 (extrapolated) = 0·2947 cm.$^{-1}$.
B''_e = 0·2955 cm.$^{-1}$.
r''_e = 1·893 × 10^{-8} cm.
α'' = 0·0016 cm.$^{-1}$.
D'' = − 19·6 × 10^{-6} cm.$^{-1}$.

B'_e = 0·2219 cm.$^{-1}$.
r'_e = 2·184 × 10^{-8} cm.
α' = 0·0018 cm.$^{-1}$
D' = − 23·1 × 10^{-6} cm.$^{-1}$.

The B'_v and B''_v values obtained from the partial analyses of the (4,19) band with head at λ4842·2; (4,22), at 5309·9; (5,22) at 5193·7; (5,23), at 5359·7; (6,23), at 5249·8; (6,24), at 5418·7; (6,25), at 5596·1; (7,25), at 5472·5; and (7,27), at 5840·2 A. are also included in the table. The B''_8, B''_7 and B'_0 values included in the table were obtained from an unpublished M.A. thesis (1941) of Mr. F. J. Wilson of the University of Saskatchewan, Saskatoon, an extract of which was kindly sent to me by Prof. G. Herzberg. The B''_4, B''_3 and B''_2 given in the table

were obtained by Olsson. The values of B'_3, B'_2 and B'_1 given by Olsson differed from those found by me, although the $\Delta_2 F'_2$ values were practically the same. Olsson's $\Delta_2 F'_2$ values for the $v' = 3$, 2 and 1 vibrational levels were, therefore, replotted and are also given in the table.

A complete report on the results obtained so far will be published in the *South African Journal of Science*. The perturbations observed in the $v' = 2$, 4, 6, 7 and 8 levels are being investigated further.

S. M. NAUDÉ.

Merensky Institute for Physics,
University of Stellenbosch,
Stellenbosch. Dec. 8.

[1] *Proc. Roy. Soc.*, A, 132, 310 (1931).
[2] *Phys. Rev.*, 37, 903 (1931).
[3] *Z. Phys.*, 100, 656 (1936).

Open Packing of Spheres

MR. S. E. ACKERMANN'S axiom[1] that spherical lumps of coal of equal size have the same bulk density irrespective of the actual size is surely applicable to any symmetrical arrangement of such spheres, including the closest packing. The arrangement of spheres which he uses in his first calculation is symmetrical and satisfies the axiom, but is not a stable arrangement which would be attained by pouring the spheres into a box. His statement that the closest packing gives an increase in density as the size of sphere is decreased appears to be derived from an incorrect conception of what constitutes the closest packing. This is, of course, the arrangement in which each sphere touches twelve others (not eight), lines joining the centres forming a system of regular tetrahedra, and is the stable one which is taken up automatically.

Using Mr. Ackermann's nomenclature, the number of spheres per cubic foot is $n^3\sqrt{2}$, and the bulk density becomes $\frac{\pi}{6}\sqrt{2}$, or 0·739. This relation holds so long as the spheres are small compared with the dimensions of the container. A smaller density will obviously result if there are spaces nearly but not quite large enough to accommodate further spheres, and which are of the same order of dimensions as the container. Such a condition applies to the later examples quoted by Mr. Ackermann, but the results obtained even with the true optimum packing are obviously specific to a 10-in. cube and are not, therefore, of general application.

S. G. FOORD.

17 Balcaskie Road,
Eltham, S.E.9.

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Human Chromosomes

IN the last few years chromosome studies have made great progress both in theory and in methods. These methods are, however, little known outside genetical laboratories.

The application to human chromosome studies of the techniques developed in cytological laboratories has been a particularly useful complement to the histology of bone marrow, and its relations to normal and pathological hæmopoiesis. The results of this kind of work in hæmatology have been partly published[1,2], and the detailed morphology of human chromosomes is at present under investigation.

The accompanying photomicrograph from a slide made by the acetocarmine squash method[3] shows a metaphase plate in a mononucleated bone marrow cell obtained by sternal puncture.

So far as I am aware, no photomicrograph of human chromosomes as detailed as those obtained by such a method has been published.

B. M. ŚLIŻYŃSKI.

Department of Biology and Genetics,
Polish Medical School
and Institute of Animal Genetics,
University of Edinburgh.
Feb. 8.

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Distribution of the *Rh* Factor in Indians

DURING the course of an inquiry into the incidence of hæmolytic anæmias in Bombay, it became evident that although a mild form of jaundice was common in the new-born, erythroblastosis fœtalis was not encountered in any of the 3,000 consecutive labour cases admitted to the Nowrosjee Wadia Maternity Hospital during the last six months. We were therefore interested in studying the distribution of the *Rh* factor in Indians. Bloods from 100 Indians were tested against known human anti-*Rh* sera (technique Taylor[1]). The results are tabulated below:

	O		*A*		*B*		*AB*		
	Rh+	*Rh*−	*Rh*+	*Rh*−	*Rh*+	*Rh*−	*Rh*+	*Rh*−	Total
Hindus:									
Male	12	−	13	−	9	−	4	−	38
Female	12	−	11	−	6	−	3	−	32
Muslims:									
Male	−	−	1	−	−	−	1	−	2
Female	1	−	−	−	1	−	1	−	3
Parsees:									
Male	1	−	6	−	1	1	−	−	9
Female	2	−	−	−	2	−	1	−	5
Christians:									
Male	−	−	1	−	−	−	−	−	1
Female	5	−	1	1	3	−	−	−	10
Total	33	−	33	1	22	1	10	−	100
British:									
Male	7	1	6	1	1	−	−	−	16

Bloods from 16 British persons were tested by the same technique to ensure that the anti-*Rh* sera had not deteriorated during transit. Two out of 16 bloods were found to be *Rh*— as anticipated.

These results are reported because of the growing interest in the hæmolytic diseases of the new-born and the findings of Greval and Chowdhary[2] as well as of Das Gupta[3] from the same laboratory that 10 per cent of Indians tested by them were *Rh*—. We believe that the difference between our results and those of other workers in India may be due to the fact that they have been using sera (after suitable dilutions) of animals immunized with red cells of rhesus monkeys. Such immunization leads to the development of anti-*Rh* as well as other agglutinins to a variable extent. It is not certain that the titre of the anti-*Rh* agglutinin is higher than that of other agglutinins in all cases. We believe, therefore, that a dilution of the immune animal serum to any particular extent (without known *Rh*+ and *Rh*— human bloods as controls) is not a justifiable procedure for determining the incidence of the *Rh* factor in any given population. We would recommend the use of immune animal sera which have been absorbed with known *Rh*— red cells for this purpose. Forty-four bloods out of the above hundred were tested with absorbed immune guinea pig serum and gave results identical with those obtained with human anti-*Rh* sera.

In the above series, none of the seventy Hindus tested showed an *Rh*—. One *Rh*— person was found among the fourteen Parsees and one among the eleven Indian Christians. The Hindus constitute 85 per cent of the labour cases in the Maternity Hospital. These findings may suggest interesting anthropological problems. A detailed report of the investigation will be published elsewhere.

We are deeply grateful to Prof. R. A. Fisher for his interest in this work, to Dr. George Taylor, Galton Serum Unit, Cambridge, for the gift of dried human anti-*Rh* sera and to Dr. Janet Vaughan for bringing them to us. We are indebted to the authorities of Nowrosjee Wadia Maternity Hospital and to Major P. Warmold, for facilities in collecting blood samples.

V. R. KHANOLKAR.
L. D. SANGHVI.

Tata Memorial Hospital,
Bombay.
Jan. 18.

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Influence of Sodium Chloride on the Formation of Melanin

VARIOUS widely differing diseased states with two features in common, melanuria and decreased blood sodium chloride, have been reported[1]. The inhibiting effect of ascorbic acid on the formation of melanin from tyrosine, 3 : 4-dihydroxyphenylalanine and adrenaline is well known[2–5]. It is also known that the oxidation of ascorbic acid is inhibited by sodium chloride[6].

The oxidation of tyrosine, 3 : 4-dihydroxyphenylalanine, tyramine and adrenaline to melanin by tyrosinase, and in the case of 3 : 4-dihydroxyphenylalanine non-enzymatic oxidation, in the presence of uniform concentration of ascorbic acid but with two different concentrations of sodium chloride, has been investigated. Substrates have been used at an arbitrary strength of 0·02 per cent; ascorbic acid at the physiological strength of 0·0012 per cent[7]; sodium chloride (*a*) physiological, 0·9 per cent and (*b*) 0·5 per cent. In the first two experiments the solutions were adjusted to *p*H 7·4 with sodium bicarbonate; in the remainder the solutions have been prepared in phosphate buffer electrometrically determined at *p*H 7·42. Potato tyrosinase has been used throughout.

In the first six experiments the rates of oxidation were estimated by naked-eye comparison of the coloured products. All showed accelerated melanin formation in the solution with the smaller concentration of sodium chloride. Fifteen experiments were carried out in the Warburg apparatus. Again all showed increased rate of oxidation in the solution containing the smaller percentage of sodium chloride. The probability of twenty-one results in the same direction being due to chance is 1 in 1,048,576. The average increase of oxygen uptake by the solution containing 0·5 per cent sodium chloride was 6 per cent, which is a small value in view of the fact that the estimated error of the manometric method is about 2 per cent[8]. Though the statistical significance of these results is beyond doubt, a confirmation by a more delicate method seemed desirable. It was noted that the difference was most marked when dilute enzyme was used, that is, when the conditions approached nearer to the physiological. But dilute enzyme necessarily prolongs the experiment, and it was found that after two and a half hours the risk of bacterial contamination arose. No method of sterilization of the reacting fluids and apparatus being available, this method was abandoned and two experiments carried out with the absorptiometer, using dilute tyrosinase. In the first of these, after four hours, the 0·5 per cent sodium chloride solution showed an increase in oxidation products of 11·5 per cent. In the second, one solution contained 0·9 per cent sodium chloride, the other none. After five hours the solution without sodium chloride contained 25·3 per cent more oxidation products than the other. The absorptiometer is stated to be accurate to within 1 per cent, so there is no doubt as to the reality of these differences.

The above results demonstrate the influence of sodium chloride, with ascorbic acid as an intermediary, on melanin formation *in vitro*. Whether this has any bearing on the physiological production of melanin is a subject for investigation. However, it is considered that it may throw some light on pathological melanin formation. The cause of the hyperpigmentation in Addison's disease has always been a disputed question[9–11]. The best-known theory is that of Bloch[12–14], but this postulates disease of the adrenal medulla, which is by no means always found at autopsy[11–16]. The following hypothesis is considered to be more in agreement with the autopsy findings in that it attributes the hyperpigmentation to destruction of the cortex. The established facts in Addison's disease are decrease in blood sodium chloride, decrease in ascorbic acid, and increase in production of melanin. It is known that when the cortical activity is diminished the sodium chloride content of the blood falls. It is suggested that as a result of this, the ascorbic acid is not so well protected against oxidation and its concentration also falls. Because of this the melanogen, whichever of the hydroxyphenols it is[5], is more open to attack by oxidizing enzymes, and increased melanin production takes place.

I am greatly indebted to Prof. H. S. Raper and Dr. L. P. Kendal for valuable advice and access to the absorptiometer in the University of Manchester, and to Capt. H. Grüneberg for much helpful criticism. The work has been carried out with the aid of a grant from the Government Grant Committee of the Royal Society.

A. J. LEA.

Medical Services,
Ministry of Pensions,
Norcross, Blackpool.
Jan. 30.

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Susceptibility of Grasses to Manganese Deficiency

FROM the literature it would appear that the manganese requirements of the different species of grasses has received but scant attention. In general[1], it is considered that grass is much less susceptible to manganese deficiency-disease than oats and some other crops. That such a generalization is not possible has been shown by a study during the past two years of the comparative sensitivity of various species of grasses. For this purpose, a number of different species of the commoner grasses were grown in a soil-sand mixture in opaque glass pots, the experiment in every detail being conducted in a manner similar to that in which an investigation into the susceptibility of cereal varieties to manganese deficiency had previously been made by Gallagher and Walsh[2]. One experiment was started in 1943 and continued into the following year, the grass herbage being harvested in the autumn. In a further investigation arising out of this experiment, the comparative reaction of some different strains of cocksfoot was examined in 1944. In this experiment a soil growing an oat crop showing 'grey speck', mixed with its own volume of washed silica sand, was used.

In the first experiment the behaviour of perennial and Italian rye-grass, cocksfoot, timothy, annual meadow grass, couch grass (*Agropyron repens*) and fiorin was tested. As in the previous experiments with cereals[2], a series of pots comprising each species were sprayed with a 1 per cent manganese sulphate solution, this treatment being repeated on a different complete series of pots in the following year, those previously sprayed being retained for observations on the residual effect of spraying. Seven strains of cocksfoot were included in the subsequent experiment, these being *S*.26, *S*.37, *S*.143, *S*.190, *S*.204 (all Aberystwyth strains), an Irish commercial strain (from the same sample as that used in 1943) and a pedigree strain bred at the Plant Breeding Department, University College, Dublin. Twenty plants were grown in each pot, triplicate pots being sown in the case of each species and strain.

Perennial and Italian Rye-Grass. These grasses reacted in a somewhat similar manner. A month after germination, the younger leaves developed a chlorotic appearance accompanied by severe tip-withering. This condition persisted throughout the 1943 season and was also apparent in the crop of the following year. Spraying when the chlorosis first became evident resulted in the development of a normal green colour. While in the 1943 season Italian was somewhat more severely affected than perennial rye-grass, the opposite held to some extent in the next season, the effect of spraying being particularly evident in the latter instance. No residual effect from the previous year's spraying was noticed.

Annual Meadow Grass and Fiorin. Both these grasses remained stunted, and no effect resulted from spraying in 1943. In the subsequent year, sprayed fiorin plants were considerably greener than the unsprayed.

Timothy. Five weeks after germination, these plants were noticed to have a yellow-green colour, and lesions developed on the lower leaves somewhat similar to those characteristic of 'grey speck' in oats. This condition did not become severe, the plants recovering quickly. Sprayed plants were much greener, in addition to being more vigorous, than unsprayed. The chlorosis appeared in the following crop, spraying again being effective as a cure. No residual effect resulted from the previous spraying.

Agropyron repens. Early in the season a slight chlorosis accompanied by the development of small grey specks distributed over the leaf blade, and severe tip withering, appeared. Recovery from this effect took place quickly, and though in the initial stages the effect of spraying was quite obvious, later on there was no noticeable difference between sprayed and unsprayed plants. In the following season no chlorosis appeared.

Cocksfoot. A month after germination, young leaves were chlorotic and yellow-green spots had developed on the older leaves. A week later, symptoms very similar to those described for 'grey speck' in wheat[2] had developed, the specks first appearing near the centre of the lamina though sometimes nearer the tip than the base. At first there was a tendency for these specks to coalesce lengthwise forming bands parallel to the veins, but later these bands joined, the result being a withered area across the leaf, the tip then bending over. Eventually the whole leaf withered, the final effect being similar to the end stage of 'grey speck' in wheat or oats[2]. This condition developed to a severe extent and persisted until late in the season. Spraying with manganese sulphate cured this condition, first signs of recovery being evident a week after application. In the following season these symptoms again appeared though not so severely, no residual curative effect being obvious from the previous season's spraying. Spraying again resulted in normal plants.

While it was obvious at an early stage that the plants growing in the soil-sand mixture used in the experiments started in 1944 did not exhibit such pronounced symptoms of manganese deficiency as those in the previous experiment, a definite difference in the behaviour of the different strains of cocksfoot was nevertheless apparent. Again manganese deficiency showed as a chlorosis followed by 'grey speck' symptoms. *S*.26 and *S*.204 showed a moderate to severe attack, *S*.190 and *S*.143 a moderate, and

the other three strains a slight to moderate attack. It is worth noting that while the Irish commercial strain was severely attacked in 1943, only a slight to moderate attack ensued in 1944 ; and if this be taken as a basis for comparison, an idea is furnished as to the possible reaction of the other strains under more pronounced manganese-deficient conditions.

This study has, therefore, shown that different grasses react differently to manganese deficiency ; further, the effect applies to different strains of at least one grass. The fact that the 1943 investigation was carried out under conditions similar to those which obtained in the previous investigations with different varieties of oats, wheat and barley[2] enables a comparison to be made of the relative sensitivity to manganese deficiency of these latter crops and the grasses used. This reveals that, depending on species and strain, some grasses may be practically as sensitive to manganese deficiency as the more sensitive oat and wheat varieties, and much more so than the least sensitive of these. Further research in this connexion is proceeding.

I wish to thank Dr. Jenkins and Prof. Caffrey for providing grass seeds, and Dr. P. H. Gallagher for advice.

THOMAS WALSH.

Soil Science Department,
University College,
Dublin.
Feb. 1.

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Induction of Heat in Spayed Female Guinea Pigs by Subcutaneous Hormonal Implants

DURING œstrus in the guinea pig, there is a relative hyperæmia at the antimesometrial border of the bicornate uterus[1], and after suitable hormonal treatment similar vascular changes have been induced in the spayed animal[2,3]. Vaginal cornification, increase in uterine weight, and all the histological features so far recognized of a typical heat response can be elicited in spayed female guinea pigs by a simple administration of œstrogens, but the cyclic vascular change is only displayed after preliminary priming of the animals with small daily injections of œstradiol monobenzoate (0·0005 mgm. for six days) followed by a large daily dose (0·5 mgm.) for two days and a final injection of progesterone (0·2 mgm.). We believe that this antimesometrial hyperæmia in the spayed female guinea pig is not a simple manifestation of œstrogenic activity, but only becomes evident when a hormonal balance approximating to the physiological condition of normal œstrus has been obtained. It is further significant that this antimesometrial hyperæmia is a response of the adult uterus and cannot be induced in the immature guinea pig by either œstrogenic[4] or gonadotropic[5] stimulation.

The method of hormonal administration by the subcutaneous implantation of pellets, introduced by Deansley and Parkes[6], seemed to us to offer an attractive labour-saving alternative to the daily injections, by which the animal would receive a small but continuous dosage with the minimum disturbance.

One 2 mgm. œstradiol pellet was inserted subcutaneously by means of a large intravenous needle in each of twelve adult spayed guinea pigs. Invariably the vagina opened on the third day following the insertion of the pellet, and maximum cornification of the vaginal smears occurred on the sixth day. After six days, half the number of animals were given a subcutaneous injection of 0·2 mgm. progesterone, and the other half were similarly treated on the twelfth day. The animals were killed three hours after the progesterone injection. In every case the uterus was enlarged and œdematous, with a thickened endometrium showing tortuous glands here and there dilated with secretion. These œstrous reactions were particularly well marked in the 12-day group of animals. There was, however, never any antimesometrial hyperæmia—a constant feature of the guinea pig uterus during normal œstrus. In an odd uterine section of the 12-day group a localized hyperæmia could be seen on one or other side or at the mesometrial border. We had apparently failed to obtain the necessary hormonal balance to promote the normal vascular change.

It is reasonable to assume that the inevitable fibrous encapsulation of the pellet would impose a decreased rate of absorption. At first there would be a fairly constant rate of absorption with a dosage too high for priming, and then a downward gradient, finally flattening out to a reduced dosage-level. Some such absorption curve is also suggested by Folley[7]. In the normal cycle, on the other hand, œstrogenic activity rises from minimum to maximum, to attain its peak around ovulation time. The priming dose of 0·0005 mgm. in our former experiments[2] did not produce vaginal opening until the sixth day, and was then followed by large doses. Because of its more gradual, more prolonged and culminating high level of œstrogenic stimulation, this method, we believe, conforms more closely to the physiological gradient of hormonal activity during the œstrous cycle.

It can therefore be concluded that (*a*) the pellet method can provoke all the well-known vaginal and uterine reactions. It cannot, however, elicit the cyclic vascular change (antimesometrial hyperæmia), which provides a particularly delicate test of the complete uterine response to stimulation, but requires for its onset a preliminary sensitization followed by a nicely balanced quantitative interplay of œstrogens and progesterone. (*b*) The pellet method possesses undoubted advantages where the desired effect can be obtained by the administration of hormones over a long period, for example, to feminize experimentally the plumage growth of the brown Leghorn capon, physiologically to induce lactation in the cow, and clinically in the treatment of infantile uterus.

We have to acknowledge our thanks to Messrs. British Schering, Ltd., and also Organon Laboratories, Ltd., for kindly providing us with supplies of progesterone and fused œstradiol pellets respectively.

P. BACSICH.
G. M. WYBURN.

Department of Anatomy,
University of Glasgow.
Feb. 2.

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MATHEMATICS AT THE NATIONAL PHYSICAL LABORATORY

THE National Physical Laboratory is proposing to extend its activities by the establishment of a Mathematics Division. It may be of interest to sketch the scope of the project as it is at present planned, though the plans may, of course, be modified in the light of growing experience.

The general aim may best be described by an extract from the report of an Interdepartmental Technical Committee recently appointed to consider the advisability of setting up such an establishment. This Committee decided that there is a strong case for an organization which would: (1) undertake research into new computing methods and machines; (2) encourage the development of new computing methods and instruments and the dissemination of knowledge of them and of existing methods; (3) deal with problems arising from statistical science, in particular by assisting in the application of statistical methods to research, development and production problems in industry and to problems arising in the physical sciences and engineering, and by research into new statistical techniques; it would in general exclude economic, sociological and biological statistics from its purview; (4) advise on the need for new mathematical tables, and, if necessary, prepare them; (5) provide computing services for Government departments and industry; (6) act as consultant on mathematical matters to Government departments and industry.

The Committee recommended that the National Physical Laboratory should undertake these duties, and with the view of doing so the Mathematics Division is being established. It is proposed at first to organize it in three sections, concerned respectively with computations using existing machines; with statistics; and with work of the differential analyser type, including the construction of new types of machines.

For the computing section there will be a full range of modern calculating machines, including the punched-card type, and very likely new machines may be developed for specialized purposes. There will be a comprehensive library of mathematical tables. Any spare time of the section will be devoted to the tabulation of functions of general utility.

The second section will be concerned with statistical methods and their use in industry. The methods of 'quality control' of production are now well established in industry, and at the practical levels can look after themselves, but there is room for much work in a general oversight of the subject, and in the further study of data provided by 'Q.C.' records. There is also much scope for the use of statistical methods in the planning of experiments in physics and engineering in the same way as is already well established through the work of Fisher and others in the biological sciences. It is not contemplated that the work of the section should extend into biology or sociology, as this would enlarge its scope out of all proportion, and would bring it into fields which are inappropriate for the National Physical Laboratory.

The third section will deal with work using what may be described as analytical engines, including the differential analyser and other machines both existing and awaiting invention. From progress already made elsewhere in such matters, it is certain that this field is capable of great developments, but it is more difficult to predict in what directions they will lie.

In setting up a Mathematics Division there is no intention of supplanting other existing activities. There are already in the Government service a number of mathematical groups fulfilling important specialized functions; for example, the Nautical Almanac Office. These will continue to work as before, but the new Division should be able to provide service for them by advising on their methods and perhaps assisting them in times of pressure. So too there will be no supersession of industrial work in mathematics, but it is intended that there shall be close co-operation. This should encourage the development inside industry of the use of mathematical methods, which recent experience has undoubtedly shown to be of the greatest value.

BRITISH LIBRARY OF POLITICAL AND ECONOMIC SCIENCE

THE annual report of the British Library of Political and Economic Science, which is housed in the London School of Economics and Political Science, for the year ended July 31, 1944, includes a retrospect of 1933–44. In this ten years the Library added 104,450 bound volumes to its shelves, and 154,368 cards to its author catalogue. During 1934–35 the Library added to its shelves 4,549 treatises and was receiving currently 3,339 periodical titles, as against 5,445 treatises and 4,506 periodicals in 1938–39, the last year of normal working. In the years immediately preceding the War, much was done to strengthen the staff and to improve its status. This larger and more highly qualified staff enabled the whole of the administration of the Library to be reorganized and the services to be greatly improved.

The survey is largely one of the work of 1934–39. Intensive efforts were made with much success to set up an international library truly representative of the social sciences. Many complete sets of important periodicals were secured, and gaps filled in existing sets. A new system of combined work-card and draft-catalogue-card was devised to eliminate wasteful routine tasks, and, in conjunction with a new arrangement of accession registers, was used to enable the Library to check its intake by country and by subject. A revision of the existing catalogue was undertaken, and after nine and a half years intensive work has at last been completed. With regard to cataloguing the uncatalogued material, all the non-official periodicals and almost all the official periodicals held by the Library have been included; 12,732 old pamphlets have also been catalogued, although many times that number still await attention, and 5,482 non-serial official publications have been catalogued and entered in chronological sequence under the issuing department of the relevant Government. In addition, 4,852 cards have been entered for treatises discovered to be in the Library but not in the catalogue. The separate catalogue to the Edward Fry Library of International Law has been revised and some 5,000 duplicate entries inserted in the main catalogue.

One of the many real needs of the Library is an adequate catalogue room to hold not only the rapidly expanding catalogues, but also adjacent thereto a much larger collection of bibliographies and works of reference. The principal stacking problem has been that of space. Reviewing the improvements made in

the housing of readers and the staff of the Library, the survey points out that these improvements led to a heavy increase in the use of the Library. At the conclusion of the War the number of readers wishing to consult the Library's international collections in history, politics, government, economics, law and international law will undoubtedly present the Library Committee with an anxious and difficult task. A little is being done to improve the lending library established for undergraduate students. The seminar collections, like the present lending library, are too small, and those systems should be developed into real ancillary libraries. The physical damage suffered by the Library and its collection through enemy action has so far been negligible, and despite many changes in the Library staff, which has now only six members who are fully conversant with its activities, work is being carried on in the same spirit as in 1940–41.

According to the annual report for the year ended July 31, 1944, 1,675 works, 1,000 pamphlets, 206 non-serial official reports, excluding British Parliamentary Papers and Public Documents of the United States, were added to the Library, which on July 31, 1944, was receiving currently 2,457 annuals and 1,340 periodicals. It is a subscribing member of twenty-six learned societies. All British Parliamentary Papers are received regularly by the Library, which is also a "library of deposit" for the Public Documents of the United States. The total number of bound volumes now in the Library is 258,360.

CHEMICAL EDUCATION

AT a joint meeting of the London Sections of the Royal Institute of Chemistry and the British Association of Chemists, and of the London Area Section of the Association of Scientific Workers, held in London on February 21, a spirited discussion on "Chemical Education" took place. The chair was taken by Dr. G. L. Riddell, chairman of the London and South-Eastern Counties Section of the Royal Institute of Chemistry.

Various aspects of the subject were introduced by different speakers. Dr. J. R. Nicholls gave his views on the knowledge and skill expected from an analytical chemist. He stressed the need for training in fundamental chemistry and in the principles underlying the various analytical procedures. Speed and accuracy are essential and keen powers of observation are required. He suggested that chemical education should include some account of the factors which determine whether a particular chemical reaction is suitable for use on a large scale, and concluded by regretting that there are no chairs of analytical chemistry at British universities and no academic schools of research in analysis.

Dr. F. W. Stoyle discussed the requirements of a work's chemist. He said that too high a degree of specialization in a degree course should be discouraged. At the same time, efforts should be made to give students an idea of the similarities and differences between laboratory and works practice by occasional visits to factories. After employment, the graduate chemist should supplement his academic training by courses in technology and ancillary subjects such as costing, factory legislation, etc. He should attempt to improve factory technique while making due allowance for the craft of the operative.

Mr. F. A. Robinson spoke on "What is Expected of the Research Chemist". He is of the opinion that the primary requirement is a sound grasp of the principles of scientific research and, secondly, an ability to apply these to whatever problems are encountered. He must also be gifted with a healthy scepticism, inventiveness, patience, the ability to read intelligently and an interest in the utilitarian aspect of his work. The latter quality is, perhaps, most neglected in a university training, and might be fostered by informing the student of technological as well as academic discoveries.

Dr. J. Kenyon, speaking on university training, pointed out that chemistry is a wonderful blend of craft and science, and that the training of the chemist is, therefore, twofold in character. In the laboratory the aim is to acquire manipulative skill and develop powers of observation and deduction, while in the lecture room the fundamental principles of the science are acquired. He stressed the importance of the latter, stating that he does not conceive it to be the function of university training to produce youthful specialists ready to fulfil the specific requirements of any particular industry. Its function is rather to supply young men and women capable of applying the results of their training—a skilled hand, an observing eye, a well-stored mind, a critical judgment and a logical intellect—to meet the varied demands of chemical industry.

Dr. A. J. Jinkings spoke on the technical training of the chemist. He affirmed that full-time day courses at a university or technical college are somewhat academic in character and that emphasis is rightly placed on principles rather than on applications. Greater co-operation is needed between the universities and technical colleges, and more technical college courses should be regarded as adequate qualifications for a degree. He suggested that a faculty of technology in the University of London and a national technological institute to grant degrees and to co-ordinate and supervise technical training generally would be of outstanding value.

Dr. E. A. Rudge paid high tribute to the sterling qualities of the part-time graduate, who, he said, stands high in industrial value. Against the advantages he shows in training and experience, however, are serious disadvantages of narrowness in outlook, since he lacks the experience of academic life. He suggested that this could be overcome by wider provision for part-time day classes which should be integrated, where possible, into the academic course.

The discussion which followed was summarized by Dr. C. G. Anderson. A number of contributors said that during university chemical courses a certain amount of technological training and some knowledge of standard forms of plant should be given, so that graduates should not be completely at a loss on entering industry. This training would be helped by interchange between industrial chemists and university teachers, by works visits and vacation employment in industry. Training should also be given in the use of literature. Students should be given some idea of the conditions, requirements and possibilities in industry in order that they may select, to some extent, the type of work for which they are fitted. More attention should be paid to inculcating the scientific outlook quite early in ordinary school training. Part-time evening study, while valuable, is too strenuous, and more day training and State bursaries for full-time study are desirable. The opinion was expressed that there should be refresher courses

in a variety of subjects, and courses for the training of laboratory assistants and stewards; also that industry should provide special training, and apprenticeship schemes for juniors might prove of great advantage.

FLAGELLAR MOVEMENTS

THE mechanics of flagellar movements and the swimming of aquatic micro-organisms form a subject of great complexity, towards an understanding of which A. G. Lowndes (*Proc. Zool. Soc.*, **114** (111), 325; 1944) makes a critical contribution in respect of *Monas stigmatica* Pringsheim, *Peranema tricophorum* (Ehrbg.) Stein. and *Volvox* sp., and at the same time effectively refutes several statements about this process that have made their appearance in standard text-books of biology.

M. stigmatica is exceptionally sensitive to light, and although it swims actively and rapidly in subdued daylight, exposure to the light of an ordinary electric bulb induces a cessation of normal swimming. This, coupled with its high rate of movement, makes observation on, and photography of, flagellar movements and swimming difficult or impossible. Direct observation showed a maximum rate of swimming of 0·260 mm. per sec., that is, more than forty times its own length per sec.; but observations of flagellar movement at this rate of swimming were not possible. When the rate of swimming is reduced to about one twenty-sixth of normal, the long flagellum (about two and a half times the length of the cell) is held out in front of the organism, and waves which originate at its base pass regularly along it; at the same time a current is set up in the water, and this flows in the opposite direction (that is, tip to base) and past the anterior end of the organism. This is the condition of the long flagellum when the organism is moving slowly, and in the normally slow-moving *Peranema* the flagellum is also held extended in front of the cell with the anterior end of the flagellum vibrating. Stimulation causes the whole flagellum to beat violently, but this does not bring about an acceleration in the rate of movement of the cell. Instead the organism ceases swimming momentarily, and then changes its direction of movement. Hence statements that *Peranema* exhibits a slow forward movement during which undulations of the flagellum are confined to its anterior end, and a rapid movement accompanied by undulation along the whole length of the flagellum, appear to be incorrect.

Experiments with a physical model, for example, a leather thong rotated under water, show that it is possible to propel from base to apex (that is, from the attached to the free end) of the thong a series of waves of decreasing amplitude and wave-length. With the thong all the energy is applied at one end, but with a flagellum, while most of the energy may be applied to its base by the attached cell, the flagellum itself generates energy so that no decrease in the amplitude or length of waves passing along it need occur. Increasing the speed of rotation of the thong causes it to swing from side to side, and it may finally twist up, but shortening it increases its stability. When two thongs are attached to the arms of a Y-tube which is itself attached to a spindle and the whole rotated rapidly under water, the thongs bend outwards, and if the spindle moves forward the thongs bend backwards. If, however, the spindle is rotated relatively slowly, a current of water is caused to flow towards the base of the thongs and at this rate of movement the thongs do not bend outwards.

In *Monas*, when the swimming is slow, the flagellum is extended forward, but if the movement is rapid the long flagellum bends and trails behind the cell and causes the organism to gyrate and rotate. It is probable that in other fast-moving organisms the flagella trail behind and are not extended in front of the cell as they are in slow-swimming types. In *Volvox*, a slow-moving cœnobial alga, the pairs of cilia remain fully extended and each pair draws a current of water towards the surface of the cœnobium, but the precise contribution that these currents make towards the movement of the *Volvox* colony is not clear.

L. G. G. Warne.

FOOD IN HOSPITALS

AN interesting article in the *Lancet* (61, Jan 13, 1945) discusses the monotonous, badly cooked and often scanty menus provided by hospitals. The fault lies, the writer concludes, not only with the hospitals, which fail to appreciate the importance of correct feeding and, in most instances, to employ a single experienced food officer with sufficient influence over the hospital's income, but also with the medical men, who do not insist that their patients' needs are properly met.

The quantity of food in hospitals is often insufficient and it has to be eaten in a hurry, for the nurses have to be getting on with the next job. The medical man could criticize the arrangements on all these grounds, and he should do so, paying special attention to the quality of 'light diet', when it is ordered. The blame has to be distributed between the hospital steward, the matron, the cooks, the out-of-date kitchen equipment, the methods of preparing, carving and serving the food, its transport along draughty corridors on unheated trolleys with delays, wilful or inevitable, on the way, and so on. The solution of this problem requires, the writer concludes, a more unified control. The prescription of diets is, and must remain, part of the treatment; the ward sister, who knows her individual patients' likes and dislikes, should interpret the prescriptions; but the buying, cooking and distribution of the food should not be done by three separate officers. Further, adequate meals should be provided throughout the day, inexpert buying and failure to use the open market should be eliminated, sufficient skilled kitchen staff should be provided, and the kitchen should have modern equipment and labour-saving devices.

A second article (*Lancet*, 94, Jan. 20, 1945) discusses the question: What is good feeding? The hospital should construe scientific knowledge of food values with the caterer's art of producing appetizing meals. Enough food of the right kind should be economically bought, properly stored and wisely cooked. Individual appetites vary, and those of sick people need special consideration. The lack of the important effects of the sights, smells and talk of the dining table can be counteracted by serving the food attractively. A third article (*Lancet*, 123, Jan. 27, 1945) suggests remedies for existing faults, with instances of improvements that have been made. The writer's evident understanding of the difficulties of all who are concerned with hospital food, his sympathy with them and with the patients, and his lively style, make these articles as attractive as they are valuable.

FORTHCOMING EVENTS

Thursday, April 5—Monday, April 9

BRITISH PSYCHOLOGICAL SOCIETY (at the University College of the South-West, Exeter).

Friday, April 6

At 9.30 a.m.—W. D. Furneaux: "An Experimental Study of Suggestibility and Hypnosis"; Winifred Raphael: "Surveys of Employee Attitude". At 11.20 a.m.—Hilda Lewinsky: "Psychological Aspects of Cooking for Oneself"; W. D. Wall: "Reading Backwardness in the Army". At 5 p.m.—Margaret Lowenfeld: "The Mosaic Test".

Saturday, April 7

At 9.30 a.m.—Discussion on "Psychological Implications of Culture Patterns" (Prof. T. H. Pear, Dr. A. I. Richards and other speakers). At 5 p.m.—Dr. Millais Culpin: Presidential Address. At 8.30 p.m.—Display of Instructional Films arranged by the Visual Education Centre, University College, Exeter.

Sunday, April 8

At 2.30 p.m.—An Account of the Work of the Devon Committee for Education in Mental Health and of the Committee of Professional Psychologists (Mental Health) of the British Psychological Society. At 5 p.m.—M. D. Vernon: "Perception and Understanding of Graphical Material"; Charles Burns: "Types of Problem Children". At 8.30 p.m.—Alec Rodger: "The Work of the Admiralty Psychologists"; G. Patrick Meredith: "The Problems and Methods of Visual Education".

Monday, April 9

At 9.30 a.m.—Eric Farmer: Problems in the Occupational Adjustment of the Blind: M. I. Dunsdon: "The Binet Test as adapted for the Blind". At 11.20 a.m.—I. Langan: "Demonstration of Binet Tests for Blind Children". At 11.50 a.m.—M. B. Stott: "Some Differences between Boys and Girls in Vocational Guidance". At 5 p.m.—Dr. K. J. W. Craik: "Refractory Period in Sensory-motor Action"; H. Himmelweit: "Level of Aspiration, as related to Neurosis and Temperament". At 8.30 p.m.—Open Session for Discussion.

Monday, April 9—Wednesday, April 11

SCIENCE MASTERS' ASSOCIATION (at the City of London School, Victoria Embankment, London, E.C.4). Annual Meeting.

Monday, April 9

At 5.15 p.m.—Mr. C. L. Bryant: "The Impact of Science on Common Thought" (Presidential Address).

Tuesday, April 10

At 10 a.m.—Dr. J. McG. Bruckshaw: "Physics and Economic Geology"; Mr. C. Bibby: "Health Education through School Biology". At 11.15 a.m.—Sir Alexander Fleming, F.R.S.: "Penicillin". At 5 p.m. (at the Ministry of Information Theatre, University of London, Malet Street, London, W.C.1)—Film Show and Discussion; Mr. Arthur Elton: "The Scope and Limitations of the Science Teaching Film".

Wednesday, April 11

At 10 a.m.—Mr. F. W. Cuckow: "The Electron Microscope". At 11.15 a.m.—Mr. R. Maitland: "The Chemistry of Plastics". At 2 p.m.—Discussion on "The Role of Science in the Future Educational System" (Opening speakers: Mr. A. W. Wellings and Mr. D. H. J. Marchant). At 5.30 p.m.—Mr. J. G. Crowther: "The Social Relations of Science" (Science and Citizenship Lecture).

Monday, April 9

SOCIETY OF ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. Ian R. Maycock: "Aircraft Salvage and Repair".

Tuesday, April 10

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 1.30 p.m.—Prof. B. Zaborski: "The Population of Poland".

SHEFFIELD METALLURGICAL ASSOCIATION (at 198 West Street, Sheffield 1), at 6.30 p.m.—Dr. D. W. Davison: "Some Crystallographic Effects in Metals".

QUEKETT MICROSCOPICAL CLUB (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Mr. E. Hollowday: "Notes on the Rotifera of the Aylesbury District, with special reference to the Seasonal Variation of the Plankton Species, and Freshwater Microscopic Life in General".

Wednesday, April 11

INSTITUTION OF ELECTRICAL ENGINEERS (TRANSMISSION SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. E. W. W. Double: "Distribution of Tensile Load in relation to Temperature and Sag of Steel-cored Aluminium Conductors".

Thursday, April 12

ROYAL COLLEGE OF SURGEONS OF ENGLAND (at Lincoln's Inn Fields, London, W.C.2), at 4 p.m.—Prof. F. Wood Jones, F.R.S.: Robert Jones Memorial Lecture—"Some Reflections on his Teaching of Myology".

INSTITUTION OF ELECTRICAL ENGINEERS (INSTALLATIONS SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. R. O. Ackerley: "Factors Influencing the Design of Electric Lighting Installations for Building Interiors".

Thursday, April 12—Friday, April 13

INSTITUTE OF PHYSICS (X-RAY ANALYSIS GROUP) (at the Royal Institution, Albemarle Street, London, W.1).—Conference on "X-Ray Diffraction Analysis".

Friday, April 13

INSTITUTION OF CHEMICAL ENGINEERS (at the Connaught Rooms, Great Queen Street, London, W.C.2), at 11 a.m.—Twenty-third Annual Corporate Meeting. At 12 noon—Mr. F. A. Greene: "A By-Way in Chemical Engineering" (Presidential Address). At 3 p.m.—Mr. H. W. Cremer and Mr. R. L. Fitt: "The Siting and Layout of Industrial Works".

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Annual General Meeting. Prof. E. A. Milne, F.R.S.: "The Natural Philosophy of Stellar Structure".

SOCIETY OF CHEMICAL INDUSTRY (PLASTICS GROUP) (joint meeting with the BIRMINGHAM AND MIDLAND SECTION) (at the Chamber of Commerce, New Street, Birmingham), at 6.30 p.m.—Dr. K. W. Pepper and Dr. F. T. Barwell: "Fabric-Base Plastics".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

FOOD CHEMIST in the Research Department of a well-known London firm, to carry out the analysis of a wide range of food materials packed in metal containers—The Ministry of Labour and National Service, Appointments Department, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. F.2722.XA) (April 14).

SENIOR LIVESTOCK OFFICER to be responsible for the Division of Animal Husbandry in the Department of Agriculture, Government of Jamaica—The Ministry of Labour and National Service, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. F.3844.A) (April 17).

LECTURER IN METALLURGY, with CHEMISTRY as a subsidiary subject—The Principal, Dudley and Staffordshire Technical College, Dudley (April 18).

DRAINAGE AND IRRIGATION ENGINEER by the Gambia Government—The Ministry of Labour and National Service, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. E.950.A) (April 18).

ECTURER IN ELECTRICAL ENGINEERING SUBJECTS in the Ipswich School of Technology—The Chief Education Officer, Education Department, 17 Tower Street, Ipswich (April 20).

TEACHER OF MATHEMATICS AND SCIENCE, with duties chiefly in the Junior Building School—The Principal, Technical College, Huddersfield (April 20).

TECHNICAL ADVISER TO THE EXCISE COMMISSIONER, Government of the United Provinces, India (candidates must be highly qualified distillery technologists, specializing in biochemistry of fermentation but with sufficient knowledge of chemical engineering to advise distillers on constructional and allied problems)—The Ministry of Labour and National Service, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. F.3813.A) (April 21).

LECTURER (full-time) IN THE DEPARTMENT OF NATURAL SCIENCE (candidates must have an Honours Degree in Zoology at a British University)—The Principal, Derby Technical College, Normanton Road, Derby (April 24).

ASSISTANT LECTURER IN WEAVING—The Registrar, College of Technology, Manchester 1 (April 24).

CHEMIST AND ASSAYER IN THE MINING AND GEOLOGICAL DEPARTMENT, Government of Kenya—The Ministry of Labour and National Service, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. F.3845.A) (April 28).

TUTOR IN PHYSIOLOGY—The Principal, Lady Margaret Hall, Oxford (April 30).

SECOND ASSISTANT REGISTRAR—The Registrar, The University, Old Clarendon Building, Oxford (May 5).

ASSISTANT REGISTRARY (full-time)—The Registrary, University Registry, Cambridge (marked 'Confidential') (May 12).

LECTURER IN MECHANICAL ENGINEERING—The Principal, Heriot-Watt College, Edinburgh (May 14).

LECTURER IN REFRACTORIES IN THE DEPARTMENT OF METALLURGY—The Registrar, The University, Sheffield (May 14).

UNIVERSITY CHAIR OF PSYCHOLOGY tenable at Bedford College—The Academic Registrar, University of London, c/o Richmond College, Richmond, Surrey (May 23).

LECTURESHIP IN DESIGN AND ANALYSIS OF SCIENTIFIC EXPERIMENT—The Registrar, University Registry, Oxford (May 26).

ASSISTANT LECTURER IN THE DEPARTMENT OF CIVIL ENGINEERING—The Registrar, The University, Liverpool (May 28).

LIBRARIAN—The Secretary and Treasurer, University College, Dundee (August 31).

TECHNICIAN IN THE DEPARTMENT OF ANATOMY—The Registrar, King's College, Newcastle-upon-Tyne.

GRADUATE IN ENGINEERING OR PHYSICS to teach PHYSICS and MATHEMATICS in the Abersychan Mining and Technical Institute—The Director of Education, County Hall, Newport, Mon.