NATURE

"To the solid ground
Of nature trusts the Mind that builds for aye."—Wordsworth

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NATURE

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LAND UTILIZATION AND SERVICE TRAINING IN GREAT BRITAIN

WHEN "The Threat to the Peak" was published by the Council for the Preservation of Rural England in 1931, it was the disfigurement of the landscape by incongruous and ribbon building, by highway development and to a lesser extent by electricity, water, or industrial undertakings that the Council was chiefly concerned to avert. There can be no doubt as to the value of the work of the Council in educating public opinion in this matter in the Peak district and elsewhere. While it may be true, as Dr. C. M. Trevelyan has observed, that outrages cheerfully perpetrated twenty years ago would be impossible at the present time, the threat to the natural beauty of Britain is at present much more widespread and serious to-day. Observations on landscape preservation in the Dower Report indicate the wide range of threats to some of our areas of great natural beauty, and the urgent need for legislation. Although ribbon building is officially frowned upon, dilatoriness in dealing with the planning of land use and the problem of compensation and betterment are encouraging the further extension of suburban sprawl. Even the London County Council had to be restrained by the Minister of Town and Country Planning from violating the Abercrombie plan by breaking into the green belt at Chessington with a large housing estate, and the House of Lords rejected the Leicester Corporation's proposals for a reservoir in the Manifold valley.

The unilateral and unco-ordinated plans of local authorities, as in the Ennerdale proposals of the Whitehaven Corporation and the apparent intention of the Cumberland County Council to dam Mosedale, constitute a growing menace in the absence of any effective authority to implement the proposals of the Dower Report regarding national parks. Like those of the earlier reports of the Coastal Preservation Committee and of the Geological Sub-Committee of the Nature Reserves Investigation Committee, the recommendations of that Committee still await action in spite of the urgency which was attached to them even in 1942. In spite of the Chancellor of the Exchequer's allocation of fifty millions as a national land fund to enable and to encourage the acquisition by the State of land which would otherwise be sold for commercial development, the threat to our enjoyment of the hills, the moors, the woodlands, and the cliffs of which he spoke so eloquently has grown much more sinister since April.

The most serious feature of the present situation is that, in the main, it comes from the very Departments of State which might be expected to take a wide view of the public interest. The Board of Trade, for example, has also been concerned in the Ennerdale proposals, and the action of the Minister of Fuel and Power at Wentworth-Woodhouse is sadly at issue with the Chancellor's words, as well as an illustration of the absence of satisfactory arrangements for co-ordination among departments concerned with the use of land. The Standing Committee on National

Parks for England and Wales expressed last year its concern at some of the provisions of the Requisitioned Land and War Works Bill, and it now appears that there is an even graver threat in the proposals of the Service Departments to acquire fresh land for permanent training grounds.

There has already been justifiable concern in the secrecy with which the Service Departments have hitherto shrouded their plans for the disposal of land acquired in war-time for training purposes, and a request was made in the House of Lords on July 4 for a comprehensive statement showing all the areas from which it is proposed to exclude the public. That statement has never been made, and in the debate on the Address to the Throne in the House of Commons on November 15, Mr. Hollis pressed for a public inquiry in view of the new lands which it now appears the Army is proposing to acquire. Mr. Hollis asked for a statement as to the general principle of acquisition of land for Service Departments and the principle upon which the competing claims of the different Departments of State are being settled.

The Prime Minister, in reply, made a somewhat obscure statement which Mr. Hollis, with his assent, interpreted to mean that there will in future be a public inquiry whenever the Services give notice of their intention to acquire land (whether common land or not) under the Defence Act of 1842. That is reassuring so far as it goes, but it appears that the first seven cases—Dartmoor, Braunton Burrows, Ashdown Forest, Purbeck, Martindale, Castle Martin, and Harlech Morfa—are to be decided by the Cabinet after private hearings of objections before Mr. Silkin's Inter-Departmental Committee. On this question the subsequent debate in the House of Lords on November 21 was most disturbing ; it did nothing to allay the anxiety aroused by the detailed statement of the Council for the Preservation of Rural England on questions arising out of the proposals for the retention by Service Departments of large areas of land for training purposes in Surrey, which are now being considered by that Inter-Departmental Committee.

These particular lands include commons long ago acquired by the War Department, to which the public has limited access, and others which of recent years have been acquired for war purposes or used under lease or licence, but which still remain in local ownership or in that of the National Trust. The main conclusion reached by the Council is that, although there is little prospect of the War Office relinquishing any of the main areas of common which it already possesses, the suggested acquisition of other commons of exceptional beauty and value to the civilian population represents a new invasion of unspoilt country which must arouse the strongest opposition. Their proximity to areas of dense population renders the Surrey commons unsuited for permanent military activity, and in view of their exceptional quality, their surface and environment should be protected.

The House of Lords debate shows how heavy is the task which falls on the individuals and private societies on whom Great Britain relies to preserve what is left of its scenic heritage, its natural playgrounds, potential nature reserves, and ancient monuments from sequestration and irreparable damage. It was never the nation's intention that the land yielded to the Services in the emergency should be theirs for evermore ; and apart from the ease with which it was acquired during war-time, even when, as at Purbeck, definite pledges were given for its return, these, as Lord Cranborne pointed out, are now being evaded. Moreover, if the land was in future acquired under the Requisitioned Land and War Works Act, 1945, instead of under the Defence Act of 1842, it would be easier to bring the matter under the control of Parliament. The 1945 Act gives the right of hearing before the War Works Commission to anyone interested in the land, to voluntary societies concerned with preserving the countryside, scientific societies, or local planning authorities ; if the Commission reports adversely on the Minister's proposal, he must either drop the proposal or report on it to Parliament, either House of which can pass a resolution objecting to his wish to over-ride the Commission. If such a resolution is passed the Minister's proposal lapses, and Lord Cranborne contended that this procedure is preferable ; though it has been suggested that, for the time being, sufficient safeguard in the alternative procedure might be secured by a circular to lords-lieutenants directing them to consult the county council, the agricultural executive committee, the Council for the Preservation of Rural England (Scotland or Wales) and the National Trust before they give the certificate required under the 1842 Act.

Lord Cranborne spoke with justifiable force and indignation of the inclusion of Maiden Castle in a new area in Dorset scheduled by the War Office ; and the growing list including the 15,000 acres at Torver, near Coniston, the Prescelly Hills in Pembrokeshire, Coquetdale, the Eppynt district of Brecon, the firing ranges on the Northumberland coast near Lindisfarne, Cader Idris, and the continued occupation of the estuary of the Taw and Torridge for amphibious operations, should suffice to warn any scientific worker interested in the proposals for nature reserves of any type of the need for concerted action. It was recognized in the report on National Parks in England and Wales that, in spite of the valuable prolegomena provided by the reports of the Nature Reserves Investigation Committee, the British Ecological Society and other bodies, we have made as yet little progress towards determining a national policy for the conservation of wild life. It would be rash indeed to attempt to force a premature decision on the proper scope and technique of protective and controlling action ; but in the meantime it is imperative that men of science should join forces with other bodies in the attempt to stem the present demand for land of the Services.

One such area which has been recognized for more than a generation as of the highest importance among those requiring protection because of its scientific interest is Braunton Burrows. The value of this locality is indicated in a note in *Nature* of November

30, and it is one which last year was recommended by the Nature Reserves Investigation Committee to the Ministry of Town and Country Planning among the twenty-six sites of highest priority. It can confidently be predicted that the area will be included in any list drawn up by the Ministry's Special Committee which is now sitting. The Council of the Zoological Society has already expressed anxiety at the proposal to use this area as a training ground for combined operations, and the Wild Plant Conservation Board is also concerned that adequate precautions should be taken to safeguard the rare species of plants found there. Moreover, like many other threatened areas, Braunton Burrows is marginal land, and as has been pointed out by Mr. W. G. V. Balchin, of King's College, University of London, would rapidly suffer under intensive training conditions with destruction of the vegetative cover, disturbance or destruction of the biological balance and little chance of recovery.

Geologists will note how many of the forty-seven areas recommended as geological reserves fall within the areas at present threatened, and naturalists will equally note that while the Dower Report scheduled only four coastal areas as pre-eminently worthy of being reserved for enjoyment as national parks, claims on every one of these areas have been advanced by the War Office. Criticism of such proposals and of the way in which the projected sites for national parks are being permanently earmarked for military purposes was very vigorous in the House of Lords but was virtually ignored or brushed aside by Lord Pakenham, who admitted that the War Office had already submitted a detailed schedule of its requirements of land for training purposes comprising 225 areas. There can be little hope that the areas desirable for nature reserves will be secured for that purpose unless scientific men primarily concerned join forces with fellow citizens who, from the point of view of amenities, national parks, or other considerations are concerned to resist an outbreak of land 'grabbing' on a scale not seen since the time of the Enclosure Acts.

The time is indeed short, for the Prime Minister is understood to have requested the Inter-Departmental Committee to submit its report to him by December 15. Meanwhile, the fact that on November 27 the Secretary of State for War disclosed that the Services are at present occupying 1,100,000 acres and that they have now rights over a further 1,500,000 acres under Defence Regulation No. 52, of which 750,000 acres are at present being cleared of unexploded missiles for release, may indicate that the Government has at last seen the 'red light', and that the whole matter will be reconsidered at something approaching Cabinet level if not in public. It is the manner in which the proceedings have been taken, as much as the tracts of land themselves, which has been responsible for the general indignation, and there have been good reasons for doubting whether the Minister of Town and Country Planning, nominally in control of all land use, had anything like the standing required to uphold the public's case against pressure from the senior Service ministers.

Public protest has never been blind to the fact that it is necessary for the Services to find training areas much more considerable in scale than before the War, or that to a considerable extent such training areas may have to be found in Great Britain. Admittedly it will not be easy to find, in the limited area of Britain, tracts of land the seizure of which would not call forth angry protests. What is challenged is rather whether the demands now presented represent a reasonably economical use of land, and whether any real attempt has been or is being made to adjudicate between conflicting claims in accordance with clearly defined and generally accepted principles.

The belief that the Services are being allowed to be judges in their own cause is encouraged by the secrecy in which their claims to land are advanced. It is understood that the 225 areas mentioned by Lord Pakenham represent more than half a million acres, as against a quarter of a million held in 1938. Much of this, to judge from the areas so far disclosed, is common land, not normally suitable for cultivation, and its acquisition is unlikely to disturb food production ; but criticism in the House of Lords regarding the siting of aerodromes does not suggest that the Services are likely to show much regard for agricultural considerations. Moreover, Mr. Bellenger's statement in the House of Commons on November 27 was not the comprehensive statement demanded in July, and he did not indicate whether figures he gave represent the full demands of the Services, or whether a series of fresh demands is to be presented in a manner which makes it difficult or impossible for either Parliament or the public to judge the validity of the claims.

Other questions besides that of how much land the Services need in all are evaded. Has the possibility of using Salisbury Plain, for example, as a training ground, and moving the artillery ranges to moorland areas in the remoter parts of Scotland, been considered ? How much training of recruits and regulars could be carried out in the Dominions overseas ? What would be the extra cost of using less-convenient but adequate sites outside the national park areas ?

Such questions as these, demanding facts and figures and not the assertions with which Lord Pakenham evaded the issue in the House of Lords, might well be addressed to a Select Committee if not to a Royal Commission, and the fate of any particular area should not be sealed before informed and unbiased answers are given. It should indeed be a duty of the Minister of Defence to see that the claims on land of Service Departments are rigorously scrutinized and co-ordinated before they are presented to an inter-departmental committee at all, and that when presented they are supported not by assertions but by reasoned statement and evidence that all reasonable alternatives have been examined. "Government," wrote Burke, "is a contrivance of human wisdom to provide for human wants," and it is necessary to balance differing needs against one another when all cannot be met. But there can be no acceptable decision which does not involve the recognition by all concerned—by the Services no less

than by other interests, whether scientific, agricultural or amenity—that Great Britain is a small island, and land is a precious commodity, second only to man-power in its scarcity, and demanding equally the utmost judgment and economy in its use.

It is probably still too early to assess how great and irreparable is the damage already caused to flora and fauna, apart from amenities, in those 750,000 acres which the Services are preparing to release. That some of the damage was avoidable and some even wanton is undeniable. Too much has been lost already for the danger to some of our first potential nature reserves—breeding places of rare birds, migrants and insects—involved in some of the latest proposals to be disregarded lightly, and on that ground alone scientific men should seek every opportunity of making their protest heard in company with those made on other grounds. It is, however, on the ground of spiritual values, on which the present Master of Trinity based his appeal for national parks, that the final objection must rest. If, as Dr. Trevelyan said, natural beauty stands by the side of religion, of science, of poetry and art, not as a rival but as the common inspirer and nourisher of them all, and with a secret of her own, a nation which fails fairly to take account of such values in determining its national policy will assuredly find that neither guns nor butter can repair the atrophy of the spiritual power of the people.

GALL MIDGES AND AGRICULTURE

Gall Midges of Economic Importance

By Dr. H. F. Barnes. (Agricultural and Horticultural Handbooks.) Vol. 1 : Gall Midges of Root and Vegetable Crops. Pp. 104+10 plates. 12*s*. 6*d*. net. Vol. 2 : Gall Midges of Fodder Crops. Pp. 160+4 plates. 15*s*. net. (London : Crosby Lockwood and Son, Ltd., 1946.)

THE gall midges or Cecidomyidæ are a family of rather primitive, structurally degenerate Diptera, of very small or minute size. They derive their name from the fact that the majority of species during their larval stages are plant-feeders which induce in their hosts the malformations termed galls or cecidia. But the family contains many more generalized species which live on fungi or in decaying plant material ; and a few are carnivorous, preying upon scale insects, mites, white-flies, other gall midges and the like, letting the blood of their victims so neatly that an aphid may be bled to death without perceiving the attack.

Among the gall midges are many that attack cultivated crops, often causing serious losses. Perhaps the best known of these is the Hessian fly which, according to tradition, was introduced into America in straw bedding used by the Hessian troops during the Revolutionary War. Though not a common cause of serious trouble in Great Britain, the Hessian fly is often responsible for much damage to wheat crops in the United States and elsewhere, and attempts are being made to produce varieties of wheat that are resistant to it. In the British Isles perhaps the swede midge, the pear midge, the clover seed midge and the chrysanthemum midge are the most harmful representatives.

In spite of their biological interest and economic importance, the gall midges as a group have scarcely received from entomologists the attention they deserve—although a few of the injurious species have been intensively studied. Much of the literature about them is difficult of access, and although there are monographs describing and classifying the species of gall midges, a reference book containing the biological and economic information available about them has been lacking.

Dr. H. F. Barnes has set himself the task of writing a comprehensive account of all those species of gall midges, throughout the world, that are of economic interest either as pests of crops or as beneficial insects. He is well qualified for this task ; for not only is he a taxonomist of international repute on this group of insects, but also his researches during the past twenty years have added greatly to our knowledge of their biology, their economic importance and the factors which determine the fluctuations in their numbers, the host-plant range of phytophagous species, the choice of prey among the predators—all problems of general biological interest.

The entire work will comprise an unspecified number of volumes, each complete in itself, dealing in turn with the gall midges of the various groups of crops. The first two volumes, dealing respectively with the midges of root and vegetable crops and the midges of fodder crops, clovers and grasses, have now been published. The midges are dealt with under the plants they attack, arranged alphabetically. The author is acutely aware of the pitfalls and difficulties that beset the path of the taxonomist of this group of little flies. He deprecates any attempt by the amateur to identify the species independently of their host plant and of the type of damage they produce, for "experience has shown that it is frequently more or less useless, and usually most unwise, to attempt to identify a species from keys unless biological data are available in addition". To emphasize this, the briefest possible description of each species is given, though reference to the original description is always included. Throughout the work it is the bionomics of the insect that is stressed ; the information on the biology and habits of the species of economic importance should enable entomologists to identify them.

The injurious species of gall midges present particularly difficult problems to the economic entomologist, for direct methods of control are seldom practicable, and cultural methods of prevention have to be found. Detailed knowledge of its biology and life-history is a prime need in seeking means of control for any insect pest ; but this applies with special force to pests that must be dealt with by cultural methods. To devise modifications in farming or gardening practice that will enable the crop to resist attack demands an intimate understanding of the relation between the insect and its plant host.

The author has brought together in a compact form all that is at present known along these lines about the gall midges that are pests in all parts of the world, and has directed attention to the many gaps that still exist in our knowledge. His books make no pretence to literary form : they are concentrated, fully documented accounts of known facts. But they are welcome both in providing entomologists with a ready means of reference to the information already acquired and as a stimulus to the further study of an important but somewhat neglected group of insects.

V. B. WIGGLESWORTH

SOIL AND CIVILIZATION

The Veld and the Future

A Book on Soil Erosion for South Africans. By Edward Roux. Pp. 60. (Cape Town: The *African Bookman*, 1946.) 5*s*.

Food or Famine

The Challenge of Erosion. By Ward Shepard. Pp. xi+225+16 plates. (New York: The Macmillan Company, 1945.) 12*s*. 6*d*. net.

Reconstruction by Way of the Soil

By G. T. Wrench. Pp. 262. (London: Faber and Faber, Ltd., 1946.) 12*s*. 6*d*. net.

THESE three books bear witness to the ever-increasing awareness of the world problem of soil erosion. Ward Shepard goes so far as to claim that "modern man has perfected two devices, either of which is capable of annihilating civilization. One is total war; the other is world soil erosion. Of the two, soil erosion is the more insidiously and fatally destructive. War disrupts or destroys the social environment which is the matrix of civilization. Soil erosion destroys the natural environment which is its foundation."

The three books are complementary. Wrench restates the problem and pleads for the recognition of natural laws in the symbiotic relationship of human society to the soil, Ward Shepard presents the American view and urges a practical programme for the American continent based on the recognition of the fact that man does not conquer Nature but at best has the privilege of co-operating, on terms and conditions set by Nature. Edward Roux's modest paper-covered volume is concerned solely with the South African veld—yet of the three it breaks new ground and strikes a new note. National leaders may be aware of the problems, but even the best considered schemes depend for their success on the co-operation of the individual—the ordinary farmer. The T.V.A. had to win the confidence of the local people man by man—an aspect of its successful work far too often overlooked. So Roux has written a little book in the simplest of language—for school-children, farmers and townsmen—illustrated by the simplest of line drawings of veld grasses, of the causes and cures of erosion. The book is a model of its kind because the author does not sacrifice scientific accuracy to 'popular' appeal—he succeeds in a few brief pages in making crystal clear the meaning of plant succession, climax vegetation and the all-important stabilization of seral communities which include the valuable grasses. There is only one criticism: the book ought to cost sixpence in order to secure the widest use—not five shillings.

Ward Shepard sees the solution of the problem in North America through the creation of a nation-wide organisation of land-management districts based essentially on river basins. What he calls "integral watershed development" envisages restoration of vegetation cover combined with drainage and flood control after the now familiar model of the Tennessee Valley. He devotes considerable attention to problems which are domestic rather than world-wide—to demonstrating, for example, that the public acquisition of low-grade land is not necessarily socialism, that authorities such as T.V.A. need not be "undemocratic" and that their powers can be compatible with the maintenance of "States' rights". Unfortunately, he has the too common fault of spoiling his case by overstatement. It is scarcely true to say that "soil stability in Europe was purchased at the expense of the ruthless exploitation of the soils in the new continents"—it is rather that the new lands have had to learn by painful experience the wisdom which is the heritage of the European farmer. However much credit is due to H. H. Bennett—and it is very great—it is scarcely true to say that the menace of soil erosion was not appreciated until the formation of the United States Soil Conservation Service in 1933.

It is difficult to assess the value of Dr. Wrench's book. He confesses himself the product of an English public school where no effort was ever made to arouse interest in the local environment, as a medical student led to ponder, "Why disease?", and as a student in Germany revolting against the profit motive of a mechanical age. The field he surveys is world-wide: it ranges from a correlation of the rise and fall of Rome with the substitution of slave labour and the development of an urban mentality for an earlier peasant economy, to the Second World War and its inevitable return to subsistence farming. He devotes Chapter 23 to a summary of the preceding chapters and re-emphasizes his admiration of the agricultural systems of ancient Peru, Islam and China. Quite rightly he stresses the supreme importance of returning to the soil what has been taken from it, and abhors the profligate waste of water sewage systems. But like so many others who hold to farming as a way of life, he confuses the abuse of science with its use. Instead of advocating a wise use of new knowledge he sees the only solution in a return to peasantries as the prime cultivators of the soil.

L. DUDLEY STAMP

PREHISTORIC ARCHÆOLOGY OF GUJARAT

Investigations into Prehistoric Archæology of Gujarat

Being the Official Report of the First Gujarat Prehistoric Expedition, 1941–42. By Prof. Hasmukh D. Sankalia. (Srī-Pratāpasimha Mahārāja Rājyābhisheka Grantha-mālā, Memoir No. 4.) Pp. xviii+336+31 plates. (Baroda: Baroda State Press, 1946.) 21 rupees.

THIS volume gives the results of a series of expeditions sponsored by Rao Bahadur K. N. Dikshit and led by Dr. Hasmukh D. Sankalia, with Dr. B. K. Chatterjee and Mr. V. D. Krishnaswami as collaborators. The aims of the expedition were to examine the river beds of Gujarat for the remains of palæolithic man, to investigate certain microlithic sites, and as a result to obtain a sequence of prehistoric cultures for the area. Little had been done in the district since the days of Bruce Foote, and the time was ripe for such investigations to be made.

Gujarat lies in the northern part of the Bombay Presidency. It is bounded to the north by the Aravalli Range and the Marwar Desert; to the west lies the Gulf of Cambay, southwards is the Deccan plateau, while to the east are the gorges of the Narmadā and the Tāpī and the Mewar and Malwa plateaux. Within the area occur many different kinds of geological deposits, some of riverine and some of æolian origin. Considerable archæological finds were made and numerous sections are given. The artefacts include various kinds of *coups de poing*, cleavers, disks, etc. Some 'pebble' tools were also collected, as well as a small 'flake' industry. Judging from the illustrations, it would seem that influences

both from the more northern Soan cultures as well as from the early palæolithic (*coup de poing*) cultures of south-east India are present. But it is not easy to judge solely from pictures, especially as these are the weaker spots in an otherwise excellent piece of work. A few reproductions of photographs are necessary as controls, but implements do not photograph well. Frankly, Indian draughtsmen have not yet quite learnt the art of drawing stone tools, especially difficult in these cases when the material used is other than flint or some similar substance. There are so many details the student looks for in the picture. A draughtsman of stone implements must be both an artist and an amateur of the subject. However, the drawings in this volume are much more useful than many that have heretofore illustrated works on Indian prehistory.

The microlithic finds were also very interesting and included skeletal remains which have still to be described in detail. Pottery occurred, at least in the later phases of the culture, as well as some bone tools. No micro-burin seems to have been found; at any rate this type appears to be absent from the catalogue and the illustrations. It remains still necessary, therefore, to demonstrate beyond doubt a great antiquity for these cultures and any connexion either culturally or in time with the true Mesolithic cultures elsewhere.

The volume is well got up and there are many excellent maps and sections. If in future publications the drawings could be still further improved, some really first-class work may be expected. One rather doubts the necessity for such a complete catalogue of every find; a shorter analysis of the various types collected would surely be enough and would make matters easier for the reader. But this, if indeed it is a fault at all, is one on the right side. It is to be hoped that Dr. Sankalia will continue his important investigations.

M. C. Burkitt

CHEMISTRY AND NATURE

Annual Review of Biochemistry

Edited by J. Murray Luck, James H. C. Smith and Hubert S. Loring. Vol. 15. Pp. xiii+687. (Stanford University P.O.: Annual Reviews, Inc.; London: H. K. Lewis and Co., Ltd., 1946.) 5 dollars.

IT should be unnecessary to write that the latest volume of the "Annual Review of Biochemistry" will be welcomed by biological chemists, teachers and research workers alike. In no subject is there greater necessity for the teacher to engage himself actively in research than in the fundamental aspects of the chemical processes taking place in the tissues of organisms. In few subjects do we find so vast and stimulating a field; indeed, without the periodic surveys of the "Annual Review" the teacher would stand little chance of keeping himself in the biochemical picture. One may note in passing that the present volume refers to the work of some 3,500 individual workers.

The reviewer considers that the volumes of this series should be, as they all too frequently are not, an important component of the libraries of the purely chemical and purely biological laboratory. In Great Britain there is a tendency still to regard biochemistry as a slightly unrespectable offshoot of medical physiology; how erroneous is this conception may be shown by consideration of the contributors and their articles in the present volume. The past few decades have shown the results of the impact of chemistry upon biology, but the pure chemist does not always realize that a reverse action has also resulted. The modern developments in microchemistry are largely due to the crying needs of the biological chemist who is forced to work on the milligram scale.

Besides the 'hardy annuals', some less frequently reviewed fields are covered in volume 15. "The Biochemistry of Yeast" (Neuberg) provides an unusually useful compilation; among the more exotic facts reported is that an average sample of yeast contains about 1×10^{-7} per cent of uranium. "The Biochemistry of Teeth", "Respiration of Plants", "Photosynthesis" and "Organic Insecticides" are among welcome surveys of branches of study which are not regularly reported. It appears that biochemical investigation in the realm of the higher plants is making slower progress than is parallel work among the animals and micro-organisms. Is this a relic of the developmental history of biological chemistry, or is it the result of technical difficulties in the manipulation of plant tissues? Or is it due to some lack of attraction by this field for the junior research worker? The reviewer is of the opinion that many chemical preparations containing 'marked' atoms may ultimately be most readily achieved through the active intervention of higher plants and micro-organisms. Study of the biochemical processes of the higher plants would thus seem to offer many opportunities.

Among the regular features, the article on "Biological Oxidations and Reductions" stands out by reason of being both readable to the non-expert, and providing a mine of up-to-date information. There is, however, among several chapters, noticeable overlapping; this can be due only to lack of a clear editorial directive to the contributors. "Non-oxidative Enzymes", "Carbohydrate Metabolism", "Metabolism of Proteins and Amino Acids" and "Bacterial Metabolism" provide the worst instances. Since modern studies of metabolic processes have become no less than the study of enzymic mechanisms, sometimes isolated, sometimes integrated, it is clear that such duplications in the "Annual Review" are bound to arise unless the authors are adequately briefed. Such duplications must inevitably have uselessly expended valuable time and labour, but they also waste book-space and disappoint the reader.

Examples of overlap occur in amino-acid decarboxylation, transamination and sucrose phosphorylase. The first is given two pages in one chapter, three and a half pages in a second, one and three-quarter pages in a third and two pages in a fourth. Transamination has two pages, two pages and one and three-quarter pages in three separate chapters. The phosphorolysis of sucrose by a single strain of bacterial enzyme, discussed in volume 14 in three separate chapters, now comes up for rediscussion in no less than four places.

The reviewer believes that the time may now be ripe to separate, into a new review, the regular features of "Nutrition", "Vitamins", "Growth Factors", and "Mineral Metabolism", thus leaving together the more fundamental aspects of biological chemistry. The foregoing criticisms are not put forward in a carping spirit; but in the hope that the "Annual Review of Biochemistry" may continue to improve its position as an indispensable guide to scientific investigators.

D. J. Bell

CELLULOSE CHEMISTRY FOR THE STUDENT

An Introduction to the Chemistry of Cellulose

By J. T. Marsh and Dr. F. C. Wood. Third edition revised. Pp. xii+525+23 plates. (London : Chapman and Hall, Ltd., 1945.) 32*s*. net.

THIS work was first published only in 1938, but it is now well established as an authoritative introduction to one of the most complex branches of chemical study. One of the main reasons for its success is, no doubt, the skilful way in which a balance is preserved between the extremes of theory and practice. The nature of cellulose chemistry is such that to achieve this is particularly difficult. Thus, on one side is the substance cellulose itself, with its complex chemical structure still not certain despite a large volume of physical and chemical research. On the other are everyday commodities, such as paper and textiles, which consist principally of cellulose, although the role of this substance in determining their properties is still far from being fully understood. The new-comer to the subject may well be excused a measure of bewilderment when he attempts to correlate these two extremes, but this book will go far towards eliminating it.

The preface to this new edition mentions the strengthening of those portions of the book which refer to the "non-textile aspects of the subject", thereby removing the only real criticism which the present writer felt justified in raising in his review of the last edition. In particular, fuller reference is now made to paper manufacture, brief descriptions of the usual commercial methods of pulping wood being included. Beating is also dealt with briefly (although the subject, as such, does not occur in the index). However, readers whose interests are connected with paper technology may justifiably have expected a fuller treatment of this subject than is possible in the three and a half pages allotted to it, especially in view of the importance of recent work as a guide to the physical structure of cellulose. Holocellulose, now known to be a very important constituent of chemical pulps so far as their behaviour on beating is concerned, is mentioned only as a three-line definition. However, it would be unfair to stress these points too strongly, as the authors have obviously gone to some pains to widen the background of the book, and in other respects they have succeeded in doing so.

The scope of the book follows along much the same lines as those of the previous editions. Part 1 deals with the occurrence in Nature and general physical properties of cellulose. Part 2 discusses its chemical constitution and molecular weight and structure, with special reference to the works of Staudinger and of Mark and Meyer, and to the chain molecule hypothesis. Cellulose dispersed in various reagents is the subject of Part 3 ; and modified celluloses (especially those produced by treatment with acid or with oxidizing agents) are dealt with in Part 4. Part 5 comprises nearly two hundred pages and deals at length with derivatives of cellulose. Many of these are of considerable commercial importance (for example, as a basis of rayon and high explosives manufacture) ; others play an important part in studies of the chemical structure and molecular weight of cellulose.

The book ends with density tables, good subject and author indexes, and a list of patent specifications with page references to the text. There is no bibliography, but sources of information, whether books or scientific journals, are mentioned as occasion arises. This is probably the best plan in a book intended as a guide to younger chemists.

The general standard of production of the book is high, and the illustrations are well reproduced. Some additions to the latter (depicting the structures of trees) occur in the new edition. A useful feature is the tables summarizing the effects on the chemical reactions and physical properties of cellulose of 'activation' (swelling) and of degradation. The book may again be recommended to all chemists interested in those branches of industry which are concerned with cellulose.

JULIUS GRANT

THE HUXLEY PAPERS

The Huxley Papers

A Descriptive Catalogue of the Correspondence, Manuscripts and Miscellaneous Papers of the Rt. Hon. Thomas Henry Huxley, preserved in the Imperial College of Science and Technology, London. By Warren R. Dawson. Pp. xii+201. (London : Macmillan and Co., Ltd., 1946.) 25*s*. net.

THE general and scientific correspondence of T. H. Huxley cannot fail to be of interest to a wide circle of students. His correspondents included not only men of science, but also those eminent in almost every field of learning. In 1937, through the Friends of the National Libraries, his correspondence and miscellaneous papers were acquired by the Imperial College of Science and Technology, and afterwards a few additions have been made by private donors. Mr. Dawson was entrusted with arranging, classifying and cataloguing this large mass of documents, comprising some 4,500 letters to and from about 850 correspondents, and the results are presented in the present volume.

The greater part (174 pages) is devoted to scientific and general correspondence. The letters are arranged alphabetically under the name of the correspondent, with the letters of each writer in chronological order. Each entry comprises, so far as possible, the town of origin, date, and a brief summary of the contents of the latter, with figures indicating the volume number and folio of the Huxley papers. Family letters are listed in a separate section, and then follow lists of miscellaneous papers dealing with almost every subject in which Huxley was interested, including notes and materials for many of his lectures and papers. These support Chalmers Mitchell's observation, contained in an appreciation of Huxley written soon after his death, that "His literary style, his brilliant rhetoric and acute disputation came to him slowly ; they were the outcome of laborious effort and continual practice."

The papers throw light on the many activities in which Huxley took part, and will be invaluable to biographers and all students of the intellectual development of the nineteenth century. The catalogue is beautifully printed on paper of a quality that has become all too rare in recent years. One or two slight errors in the scientific names are possibly the result of Huxley's very illegible handwriting, and do not detract from the general high standard of this useful work.

E. HINDLE

TYCHO BRAHE (1546–1601)*

By Sir H. SPENCER JONES, F.R.S.
Astronomer Royal

DURING the Middle Ages, the long period that elapsed between the fall of the ancient civilization and the Renaissance, scarcely any progress was made in astronomy in the Western world. The theory of the universe which was almost universally accepted during these centuries was the cosmology of Aristotle; superposed upon this was the Ptolemaic system of epicycles and deferents, which provided a mathematical representation of the movements of the planets, on the basis of which their positions could be computed and published in the ephemerides.

Copernicus brought about a great revolution in outlook by placing the sun at the centre of the universe and assuming the earth to revolve around it and to rotate on its axis. A considerable simplification of the Ptolemaic system resulted; but Copernicus was still tied to the old idea of circular motion and was compelled to retain many of the epicycles and deferents of Ptolemy in order to account for the observed movements of the planets. In his day, the objections to the movement of the earth seemed strong, for the principles of dynamics had not been formulated; the Aristotelian idea that the solid earth was in the centre of the universe because all heavy things moved downwards towards the centre seemed common sense. So the philosophic point of view of the Copernican theory was slow in gaining acceptance, though it was found convenient to use it as a mathematical representation of planetary motions. The Prutenic Tables, based upon the Copernican theory, were an improvement upon the Alphonsine Tables, based upon the Ptolemaic theory.

Copernicus was primarily a mathematician and philosopher; he made but few observations and did not add many facts to natural knowledge. The errors of the Prutenic Tables were considerable; Copernicus had told Rheticus that he would be pleased if he could make his theory agree with observations to within 10′; but, in fact, the errors of the theory could be as large as a few degrees. The available observations were too few in number and their errors were too large either to determine with sufficient accuracy the fundamental numerical constants necessary for the development of any theory, or to enable the theory to be adequately tested by observation.

The prime need of astronomy was a large stock of observations of a higher degree of accuracy. This need was met by the work of the great Danish astronomer, Tycho Brahe. Though he himself did not accept the Copernican system, his accurate and systematic observations provided the proof that some of the fundamental ideas of the Aristotelian cosmology were not tenable, and enabled Kepler to express the true laws of planetary motion in Copernican terms. The work of Kepler and the discoveries of Galileo completed the revolution in thought which Copernicus had commenced, and compelled the abandonment of ideas which had been universally accepted for fourteen centuries.

Tycho Brahe was born on December 14, 1546, at Knudstrup in Scania, the southernmost province of the Scandinavian Peninsula, which then belonged to Denmark. He was the second child and eldest son of Otto Brahe, a member of an ancient noble family, who later became a privy councillor, lieutenant of various counties and then governor of Helsingborg Castle. His mother, Beate Bille, was afterwards made Mistress of the Robes to Queen Sophia of Denmark. His father's brother, Jörgen Brahe, who was childless, had been promised by Otto that if he had a son Jörgen could bring him up as his own. The fulfilment of this promise was claimed in vain, but when a second son was born Jörgen carried off Tycho by stealth. He was brought up at his uncle's seat at Tostrup until, at the age of twelve, he was sent to the University of Copenhagen to study rhetoric and philosophy, as being most necessary to the career of a statesman, for which he was destined by his uncle. An eclipse of the sun on August 21, 1560, visible in Copenhagen as a partial eclipse, attracted the boy Tycho's attention because it had been predicted. He had already begun to take an interest in astrological predictions, and he now became curious about astronomical matters. He bought a copy of the works of Ptolemy, and with its study his interest in mathematics and astronomy grew.

Jörgen Brahe did not look with favour on his nephew's scientific interests. So, in 1562, he sent him to the University of Leipzig with a young man, Anders Vedel, as tutor. Vedel, who later became Royal Historiographer, had the task of seeing that Tycho's studies were such as befitted a nobleman. Tycho, however, sought the acquaintance of the professor of mathematics and continued his study of astronomy surreptitiously. He bought a small celestial globe from which, when Vedel was asleep, he learned the names of the constellations. He procured a copy of the Alphonsine Tables, based on the Ptolemaic system, and of the Prutenic Tables, based on the Copernican system, and, when only sixteen years of age, perceived that neither agreed with the true positions of the planets, the errors of the Alphonsine Tables being the greater; for these first observations he used a pair of ordinary compasses for the rough measurement of the angular distances between planets and stars. He observed the close conjunction of Saturn and Jupiter on August 24, 1563, and found that the Alphonsine Tables were a whole month, and the Prutenic Tables a few days, in error as to the time of conjunction. Vedel gradually came to recognize that the love of astronomy was so deeply rooted in his pupil that it was impossible to force him against his will to the study of things in which he was not interested.

The first indication of Tycho's innate practical talent was shown in 1564. He had provided himself with a 'radius' or 'cross-staff', in order to obtain more accurate observations, and he soon discovered that the graduations on the staff did not give the correct angles. He tried to get money from Vedel for a better instrument and, on this being refused, he proceeded to construct a table of corrections to be applied to his observations.

Soon after Tycho's return to Denmark in 1565 his uncle died and, as his relatives and other nobles looked with disfavour on his taste for star-gazing in preference to more usual occupations, he soon left again for the University of Wittenberg; but after a short while an outbreak of plague caused him to go to Rostock. There in a duel he lost part of his nose which, in order to conceal the disfigurement, he replaced by a substitute, made of a composition of gold and silver.

* Lecture delivered at the Royal Institution on November 26.

Tycho's zeal for astronomy must have attracted notice, for in May 1568 King Frederick II promised him the first vacant canonry in Roskilde Cathedral, the incomes of canonries being frequently used at that time to support men of learning. After some further travels he came to Augsburg in April 1569, where he made the acquaintance of two brothers, Johann and Paul Hainzel, who were interested in astronomy. Tycho had come to the conclusion that larger instruments than those with which astronomers then observed were needed to increase the accuracy of observation, and he supervised the construction for the Hainzels of a large wooden quadrant of about 19 ft. radius. He also designed a sextant for measuring angles in any plane, with which he made some observations, and he arranged for the construction of a large celestial globe, 5 ft. in diameter, made of wooden plates and covered with thin gilt brass sheets. The stars and the equator and colures were marked on it, and Tycho used it in later years for the quick solution of spherical triangles.

In 1570 Tycho returned to Denmark, probably on account of the illness of his father, who died in May 1571. He took up his abode with his mother's brother, Steen Bille, near Knudstrup, and seems to have laid aside the study of astronomy in favour of chemical experiments, until the event occurred which finally and irrevocably turned his mind to practical astronomy.

On the evening of November 11, 1572, Tycho was returning to the house from his laboratory for supper when he was startled at seeing an extremely bright star in the constellation of Cassiopeia, where, as he well knew, there had been no bright star before. He could not believe his eyes and thought it must be some strange trick of the imagination. He had recently completed a new sextant, made of walnut wood with arms 5½ ft. long, and with this he at once proceeded to measure the angular distances of the new star from the nine principal stars in Cassiopeia. The star continued to be visible for about eighteen months. When first seen it was as bright as Venus at its brightest and was easily visible to the naked eye in broad daylight. During November it continued to shine with undiminished lustre and then began slowly to fade until, in March 1574, it ceased to be visible. During the time the star was visible its colour underwent a succession of changes from white to yellowish and then to a ruddy hue.

Tycho applied a variety of methods to find whether the star had an appreciable parallax. He was unable to detect any parallax, and the conclusion drawn from his observations was that the star was more distant than Saturn and was in the firmament itself. This may seem to us a fairly obvious conclusion, but in his day it was a cardinal principle that, in accordance with the doctrines of Aristotle, the regions beyond the moon and of the fixed stars in particular were unchangeable and incorruptible. Tycho's observations of the new star proved for the first time, beyond possible doubt, that this doctrine could not be sustained.

Tycho prepared a manuscript account of his observations of the new star and of his deductions from them, with some account of its probable astrological significance. When he showed it to some of his friends, they urged him to have it printed. At first he declined, because there was a prejudice among his fellow nobles that it was not proper for a nobleman to write books. But when other accounts of the star, both written and printed, came into his hands, many of which contained a great deal of nonsense, and when publication was urged by his kinsman, Peter Oxe, the high treasurer of Denmark, he yielded. The little book, "De Nova Stella", was printed in Copenhagen in 1573. Not many copies were printed and the book is now extremely scarce. The more important parts of it were reprinted in his greater work, "Astronomiæ Instauratæ Progymnasmata", on which he was engaged during the last fourteen years of his life, and which was published in 1602 after his death.

After the publication of his book, Tycho had intended to go abroad for some time, but the journey was put off, possibly because he had formed an attachment to a young girl, named Christine. Not much is known about her, except that she was not of noble birth. Tycho was never formally married to her, but according to ancient Danish law, a woman who lived with a man, kept his keys, and ate at his table, was after three winters considered as his wife. Some years after his death, his sister Sophia and other relations signed a declaration that his children were legitimate. He had eight children in all, of whom two died in infancy. Tycho's relations considered the connexion a disgrace, not because he was not married to the girl but because she was of lowly birth, and they became estranged from him.

Early in 1575 Tycho at last started on his long-deferred journey in Central Europe. At Cassel he met a kindred spirit in the Landgrave William IV of Hesse, an enthusiastic astronomer, who had his own observatory; though Tycho never saw him again after this visit, the two men maintained a frequent correspondence and interchanged observations. After travelling in Germany, Switzerland and Italy, and meeting many astronomers, Tycho returned home at the end of 1575 with the intention of settling down in Basle; the central situation of Basle was convenient, and its University was one of the most important centres of learning in Europe.

But luckily at this juncture, King Frederick II had his attention directed to Tycho by the Landgrave William, who urged him to do something for Tycho so as to enable him to devote himself to astronomical studies in Denmark, which would not only advance science but would also bring much credit to the king and to his country. The king, for his part, was a patron of learning and was only too anxious to keep so promising a man as Tycho in his kingdom. The upshot was that he made Tycho such an attractive offer that Tycho altered his plans and decided to remain.

The chief part of the King's gift was the island of Hveen, situated in the Sound about fourteen miles north of Copenhagen, where Tycho could pursue his studies undisturbed by affairs of court and State. The document signed by the King granted "to our beloved Tyge Brahe . . . our land of Hveen, with all our and the crown's tenants and servants who thereon live, with all rent and duty which comes from that, and is given to us and to the crown, to have, enjoy, use and hold, quit and free, without any rent, all the days of his life, and as long as he lives and likes to continue and follow his *studia mathematica*, but so that he shall keep the tenants who live there under law and right, and injure none of them against the law or by any new impost or other unusual tax". The King also gave Tycho a sum of money to build a house on Hveen, and granted him an annual pension of 500 daler.

Further sources of income were provided in subsequent years. In 1577 he was granted the manor of Kullagaard in Scania, to be held during the King's pleasure, on condition that he kept the lighthouse of Kullen in order. In 1578 the use of eleven farms in the country of Helsingborg, free of rent, was given him. In the same year he was given the income of an estate at Nordfjord in Norway, until the canonry at Roskilde, of which he had been promised the reversion, became vacant. This occurred in 1579, when the canonry was conferred on Tycho, with certain obligations, including keeping the chapel of the Holy Three Kings, to which the canonry was attached, in proper repair; but he was allowed to keep the Nordfjord estate. There were from time to time some variations in and additions to these marks of the King's generosity; but during the years he lived at Hveen, Tycho enjoyed an income which, according to his own statement, amounted to about 2,400 daler a year, equivalent to about £550, a considerable sum in those days, which should have been amply sufficient for his needs.

Tycho at once set about building a residence and observatory, which he named Uraniborg, as it was to be devoted to the study of the heavens. The foundation stone was laid on August 8, 1576, but the building was not completed until 1580, though Tycho had taken up his residence there some time previously. The edifice was a palatial structure of red brick with sandstone ornaments, in the Gothic Renaissance style. The principal and central portion was in the form of a square, 49 ft. long, in two stories, containing living-rooms, library and laboratories, with eight small attic rooms above for students and assistants. On the north and south sides were round towers, 18 ft. in diameter; smaller towers on the east and west sides contained the entrances. The two main towers each had a platform on the top, surmounted by a pyramidal roof, forming an observatory. There were numerous smaller observatories. It was situated at the centre of a large square enclosure, formed by earthen walls, 18 ft. high and 16 ft. thick at the base, with the corners pointing to the four points of the compass. There were entrances at the east and west angles, and mastiffs were kept in small rooms over the gateways to announce, by their barking, the arrival of visitors. The enclosure was laid out with gardens and orchards.

In 1584, when the number of assistants and pupils had increased, and more instruments were needed, Tycho erected a second building to the south known as Stjerneborg or Star Castle, containing five underground instrument rooms, with only the roofs above ground, so that the instruments were well protected from the wind, and with a study in the centre. Subterranean passages connected the various rooms. On the walls of the study were the portraits of eight astronomers, all in a reclining posture, Timocharis, Hipparchus, Ptolemy, Albattani, King Alphonso, Copernicus, Tycho, and an astronomer yet unborn, his hoped-for descendant, Tychonides. He also established workshops, where most of his instruments were made, and installed his own printing press and even a paper mill, so that all essential work could be carried out on his own premises.

Tycho constructed a great variety of instruments, some of which were large and fixed while others were smaller and portable, so that Uraniborg had the most magnificent collection of instruments that had ever been seen. He had several quadrants, movable in azimuth, the largest having a radius of 7 ft., with a large azimuth circle; a variety of sextants for measuring the distances between celestial bodies; a large equatorial instrument; a large mural quadrant, which was his own invention, of $6\frac{3}{4}$ ft. radius; as well as various astrolabes, armillary spheres and other instruments. These instruments were constructed with great care to give as high an accuracy as possible in observation. They were made mainly of metal, whereas wood had previously been generally used. The errors of the instruments were determined, and corrections for the errors were applied to the observations. The accuracy of reading was increased by an improved method of graduation by means of transversals, in which graduations made alternately on each side of a pair of parallel arcs were joined diagonally by series of equally spaced dots; in some cases the graduations were subdivided in this way to every 10″. Improved sights were used to increase the accuracy of setting.

The observatory possessed some clocks, which had the verge escapement and foliot balance arm, which was usual at that time, before the invention of pendulum clocks. Their time-keeping properties were very poor; this was realized by Tycho, and he did not make much use of them in his observations. The mural quadrant was employed mainly for measuring meridian altitudes and not as a transit instrument. Tycho adopted an ingenious method for determining right ascensions which did not require the use of clocks. The meridian altitudes of two stars were observed with a quadrant, giving their declinations, and the distance between the two stars was measured with a sextant. The three sides of the spherical triangle formed by the Pole and the two stars being known, the difference of the right ascensions of the stars could be computed. In order to determine absolute right ascensions, it was necessary to refer the stars to the sun; for this purpose he used Venus as an intermediary. When Venus was sufficiently bright, he measured the distance between Venus and the sun, as well as their meridian altitudes, enabling him to derive the difference in right ascension between the sun and Venus. Then after sunset, he measured the distance of Venus from several bright zodiacal stars, and also the meridian altitudes. By allowing for the motion of Venus in the interval, the difference in right ascension between sun and star was obtained. These zodiacal stars were then connected with α Arietis, near the vernal equinox, each observation giving a value of the right ascension of this star. By proceeding round the heavens, the right ascensions of four, then of six, and finally of eight principal standard stars were derived. Other stars were connected with two or more of these standard stars, at least one of which was preceding and another following the star. In this way his catalogue of star positions was built up; the probable error of a position of a standard star in each co-ordinate was about $\pm$ 25″, which was a very considerable advance on the accuracy with which star positions had been previously determined.

An important contribution made by Tycho to positional astronomy was the detection of the effect of atmospheric refraction and the determination of its amount. He found that the latitude derived from the measurement of the meridian altitudes of the sun at the two solstices differed from the latitude deduced from observations of the Pole star. Having satisfied himself that the discordance was not produced by instrumental errors, he was led to explain it as the effect of refraction. He then investigated the amount

of the refraction by measuring the altitude and azimuth of the sun at frequent intervals throughout a whole day, near the summer solstice when its declination was practically stationary, during the years 1585–89. From the observed azimuth, knowing the declination and the latitude, he could compute the altitude of the sun, and comparison with the observed altitude gave him the amount of the refraction. His measurements of the refraction were, however, vitiated by assuming the parallax of the sun to be 3′, the value which had been used since the time of Hipparchus. This was the only astronomical quantity which Tycho borrowed from his predecessors. It is somewhat surprising that he did not attempt to determine it for himself; he would have found that for his instruments it was insensible.

Tycho lived at Hveen in magnificent style, with little attention to economy. The expenses of the establishment were very great and he was not infrequently in debt. Perhaps because of this, he continually neglected the obligations under which he held several of his tenures; he neglected the maintenance of the lighthouse of Kullen; he treated his tenants in an arbitrary manner with the haughtiness of a medieval nobleman, illegally forcing work from them for which they were not liable; he neglected the upkeep of the chapel which his canonry required, did not arrange for the conduct of the chapel services, and defaulted on certain payments to the widow of the previous holder, for which he was liable. There were frequent quarrels, disputes, and complaints, in which the King often had to intervene, several times paying the sums in dispute in order to settle the matter. Tycho entertained numerous distinguished visitors, who were attracted to Hveen by his growing fame; these included James VI of Scotland and several members of the Danish royal family.

Nevertheless, astronomical work was carried on assiduously. For the employment of the many instruments and for the extensive computations involved, considerable assistance was needed. During the twenty-one years that Tycho spent at Hveen, at least forty pupils and assistants, and probably many more, were employed there at one time or another.

In November 1577 a brilliant comet appeared and remained visible for more than two months. Tycho observed it diligently with his customary care, and proved beyond doubt that it had no perceptible daily parallax and that it was situated far beyond the moon's orbit. He thus gave another severe blow to the Aristotelian doctrine that comets were exhalations in the atmosphere of the earth, a view which he had formerly himself held. Tycho also made observations of the comets of 1580, 1582 and 1585, which served to confirm his conclusions. A full account of the observations of the comet of 1577 is given in the "Astronomiæ Instauratæ Progymnasmata". In the course of this work he considers the orbit of the comet and explains his views about the construction of the universe, which he had developed in 1583. Though Tycho recognized the great mathematical superiority of the Copernican system over the Ptolemaic system, he could not accept the motion of the earth. The physical objections to this motion, in the days before Galileo had laid the foundations of mechanics, seemed too strong. The motion of the earth was also against Scripture. But his strongest objections were against the immense distances and incredible sizes of the fixed stars, which the Copernican system involved. Making use of the old value of the solar parallax of 3′, he concluded that the sun had 5·2 times the diameter of the earth. He grossly over-estimated the apparent diameters of the stars, assigning a diameter of 2′ for a first-magnitude star, a value appreciably smaller than the diameters assumed by most other astronomers before the invention of the telescope. On the Copernican system, the absence of any detectable annual parallax of the fixed stars made it necessary to accept that they were far beyond Saturn; Tycho concluded that, if the earth really moved round the sun, stars of the first magnitude must exceed in dimensions the whole amplitude of the earth's orbit, which seemed to him absurd.

He therefore formulated a new system. He placed the earth immovable in the centre of the universe. The moon circled around the earth and, at twenty times the moon's distance, the sun also. But the five planets moved in orbits centred at the sun, which were carried around the earth with the sun. Just outside the orbit of Saturn, the finite sphere of fixed stars rotated once every twenty-four hours. The orbits of Mercury, Venus and Mars intersected the orbit of the sun about the earth, which would have been impossible on the Aristotelian doctrine of solid crystalline spheres. One more long-held conception thus had to be discarded. The comet was supposed by Tycho to move around the sun in a circular orbit outside that of Venus, in the direction opposite to that of the planets. This involved difficulties, because in order to represent the observed positions, he had to assume a variable rate of motion. He remarked that the introduction of an epicycle might account for this, but that probably ephemeral bodies like comets do not move with the same regularity as planets.

This system avoided the most serious criticisms to which the Copernican system was subjected, but preserved all its mathematical advantages, the two systems being essentially identical mathematically. As the Ptolemaic system became increasingly indefensible, the Tychonic system became acceptable to those who were unwilling to accept the Copernican system. It thus served as a stepping-stone from the Ptolemaic to the Copernican system and, though Tycho himself did not accept the latter, his work greatly helped to secure its ultimate acceptance.

Tycho was extremely proud of his system, which was the cause of a violent quarrel with Reymers Bär, who developed, probably quite independently, a system very like Tycho's but accepting the rotation of the earth, which he published in 1588. Reymers had been at Hveen for a short time in 1584, and Tycho accused him of having stolen the idea from some of his manuscripts. Reymers retaliated with a counter-charge of theft against Tycho, and the quarrel was only terminated by the death of Reymers in 1600.

In 1588, the year of the publication of the book on the comet of 1577, King Frederick died. His eldest son, Prince Christian, being only eleven years of age, a regency of four protectors, elected from among the nobles, was formed. They were friendly to Tycho and paid off for him a debt of 6,000 daler which he had incurred; they also undertook to keep the buildings at Hveen in repair at the public expense. In 1592 the young king-elect paid a visit to Hveen. But the continued neglect by Tycho of obligations under his tenures and his high-handed and arbitrary acts towards his tenants gradually undermined his position in Denmark. The death in 1594 of the Chancellor, Niels Kaas, who was one of the four

protectors and a powerful friend of Tycho, made his position less secure. Tycho began to entertain thoughts of leaving Denmark and, perhaps with this in view, disposed of his portion of the family estates at Knudstrup. In 1596 King Christian was declared of age and crowned at Copenhagen. He was of an economical disposition and soon began to introduce economies. He was not interested in astronomy like his father; he no doubt regarded the heavy expenditure at Hveen as an extravagance. Tycho lost first his Norwegian fief, and then the pension of 500 daler. His position at Hveen finally became untenable. Observations were discontinued in March 1597, and in the following month he left the island where he had worked for twenty-one years, removing his furniture, his printing press and his instruments, with the exception of the four largest ones, which were left behind temporarily as being too troublesome to move. Almost immediately, Tycho was deprived of his canonry, which was given to his enemy, the new Chancellor, Friis. He spent the winter at Rostock, and while there he prepared and printed a description of his instruments, together with a short account of his life and of his principal discoveries, under the title of "Astronomiæ Instauratæ Mechanica". He also prepared and circulated some copies of his catalogue of 1,000 stars; only 777 of these had been adequately observed, the remainder being added, though insufficiently observed, to make up the number.

After some wanderings, Tycho sought and obtained the patronage of the Emperor Rudolph II, a man deeply interested in science but thoroughly incompetent in the management of public affairs. The Emperor granted him a salary of 3,000 florins a year and promised him a hereditary estate whenever one should fall to the crown. Tycho arrived in Prague in June 1599; but, not wishing to live there, he was given the choice of three castles, and selected Benatky, on the River Iser, about twenty-two miles north-east of Prague. He immediately began altering the building and constructing an observatory and a laboratory. His family joined him, and he sent for his other instruments, including those left at Hveen, but there were many delays in transport and they did not reach Prague until November 1600. Funds for the alterations proved difficult to obtain, as the Bohemian exchequer was always empty; so in July 1600 Tycho left Benatky and returned to Prague, eventually moving into the house of the late Vice-Chancellor Curtius, which the Emperor purchased from his widow.

Tycho was meanwhile endeavouring to obtain assistants. He entered into negotiations with Johann Kepler, who was then about twenty-nine years of age and professor of mathematics at Gratz, and had gained a considerable reputation by the work, "Mysterium Cosmographicum", in which he derived a relation between the distances of the planets and the five regular polyhedra. Kepler, as a Protestant, was obliged to leave Gratz when the Archduke Ferdinand vowed to root out all the heretics from his dominions. Arriving in Prague early in 1600, he joined Tycho at Benatky. Kepler was given the theory of Mars to investigate, but trouble soon developed between him and Tycho because he was treated as an ordinary assistant and not as a man of recognized scientific standing. He left Benatky and returned to Prague. But through the mediation of Jessenius, a mutual friend, a reconciliation followed. Kepler's position was for a time insecure, but eventually he was promised the office of Imperial mathematician on condition that he should work with Tycho on the new planetary tables, which Tycho had received the Emperor's permission to call the Rudolphine Tables.

The observations made in Bohemia were on a limited scale, in the first instance because of the long delays in the arrival of the instruments; and then after their arrival, most of them were stored in the basement of Curtius's house until an observatory could be prepared for them, and were not, in fact, ever used again. But considerable work was done in the preparation of observations for publication and in their discussion, as well as in investigations of lunar and planetary theories. Some important discoveries in the theory of the moon were made. Hipparchus had discovered the equation of the centre and Ptolemy had discovered the evection, these being the two principal inequalities in the moon's motion. Tycho discovered two further inequalities. One arises from the variation in the magnitude of the residual solar attraction on the earth–moon system during a synodic month, and vanishes at opposition, at conjunction, and at quadratures; it is known as the variation. The other is due to the annual variation of the earth's distance from the sun, and is known as the annual equation. He also discovered that the inclination of the moon's orbit to the equator had a small regular oscillation and that the motion of the moon's nodes was variable. These contributions to lunar theory were made possible because Tycho did not confine his observations to the times when the moon was near opposition, conjunction or quadrature, but observed the moon throughout her monthly course, both on and off the meridian.

Among the many other contributions made by Tycho, mention may be made of his determinations of the constant of precession, of the annual motion of the sun's apogee, and of the length of the year, which were all more nearly correct than any previous determinations. He also disproved the reality of 'trepidation', a supposed oscillatory motion of the equinoxes along the ecliptic, which the Arabian astronomer, Tabit ben Korra, claimed to have discovered about the year A.D. 900, and which had been universally accepted, even by Copernicus.

During the year 1601, Tycho's health was failing, and towards the end of the year he was seized with an illness which, after a few days, terminated fatally on November 24, 1601. Before he died he begged Kepler to finish the Rudolphine Tables as soon as possible, and expressed the hope that he would demonstrate their theory according to the Tychonic system and not by that of Copernicus. Kepler obtained possession of his observations, which have never been published except in an imperfect form.

The elaborate buildings on Hveen did not long survive. Neglected after Tycho's departure, they soon began to fall into ruin, and in 1623 were mostly pulled down to build a new dwelling-house on the site of Tycho's farm. By the middle of the century, nothing remained except the foundations of Uraniborg and the great earthen walls which enclosed it. The instruments were claimed by Tycho's son-in-law and former assistant, Tengnagel, and Kepler was disappointed in his hope of continuing observations with them. They were stored in a vault under Curtius's house, where they remained until they were destroyed in the disturbances which followed the rising of the Bohemians against the House of Hapsburg. But their great work was done; the invention

of the telescope soon made instruments of the type used by Tycho obsolete.

Tycho's greatest heritage was his large stock of observations, and these were fortunately safe in Kepler's keeping. The circumstances which made Tycho decide to leave Hveen proved a blessing in disguise, for otherwise Kepler would never have been given the opportunity his genius demanded. The observations of Tycho provided the material which enabled Kepler to formulate his famous laws of planetary motion. The deduction of these laws was made possible by the care which Tycho had always taken to obtain the greatest accuracy of which his instruments were capable, and by the systematic manner in which his observations were made. The prevailing custom had been to make a few observations near opposition or conjunction, and at other times only when required to supply some particular datum needed for a point of theory. But Tycho observed the moon and planets all round their orbits, both on and off the meridian, and the sun almost daily for many years.

Tycho was a man with many faults. We cannot admire his imperious, overbearing manner, his grasping character, his failure to carry out his obligations, his treatment of his tenants, his quarrelsome disposition. But of his life-long devotion to astronomy there is no question. In practical and spherical astronomy he made the first great advance since the days of the Alexandrian school. He realized that the discovery of the true motions of the heavenly bodies could be achieved only by a large stock of observations made with all possible accuracy; by the construction of improved instruments, by scrupulous care in making his observations, and by his unwearied labours, continued for many years, he opened a new era in astronomy. He is justly regarded as one of the greatest astronomers of all ages.

GERMAN PHYSICAL SOCIETY IN THE BRITISH ZONE

GÖTTINGEN MEETING

THE first meeting of the reconstituted "German Physical Society in the British Zone" took place at Göttingen on October 4, 5 and 6, the new Society actually being founded on October 5.

Because of difficulties of transport and accommodation, only about five people attended from each of the nine universities and technical high schools now operating in the British Zone. A few physicists from Berlin were also present, and the meeting gained a slightly international character through the presence of a few British and Dutch men of science. Altogether, approximately 150 people attended the meetings, which were held in the large lecture hall of the Rockefeller Institute for Applied Mathematics at Göttingen; many lively discussions on a smaller scale took place in the Physics Department of the University.

One could scarcely fail to be impressed by the number of German physicists who had managed to keep their fundamental research work going right through the War, and to maintain it under present conditions. Perhaps this may indicate the failure of the Nazi Government to ensure the collaboration in military research of certain of their most important scientific workers, even under the urgent stress of war. This applies in particular to the physicists now working or residing at Göttingen, which at present is unquestionably the most important centre for physics in the zone, due both to its undamaged condition and the valuable old traditions. Of the well-known physicists now living there and participating in the meetings one might mention Planck, v. Laue, Pohl, Heisenberg, Becker, O. Hahn and Kopfermann.

The foundation meeting of the new Society was not remarkable except for one or two points. It was felt to be essential to make a fresh start rather than to attempt to continue the old German Physical Society, since the latter was taken over (*gleichgeschaltet*) by the Nazis, an event which did not take place, however, until 1938. As an incident illustrating the resistance offered to the Nazis by the Society, the fact was mentioned that when J. Stark insisted in 1933 on becoming president of the Society, no more than two votes were cast in his favour. The president of the new Society is Prof. v. Laue.

It is impossible to attempt to give a complete report of all contributions to the meeting, and some of the more interesting ones will therefore be selected. An essential part of the meeting was felt to consist in the private discussions and demonstrations at the University laboratory.

Lauterjung reported on changes in sensitivity of Geiger–Müller counters to ultra-violet light of wavelength 313 mμ, brought about by illumination with γ-radiation. The counters consisted of magnesium, filled with a mixture of argon and neon. The γ-radiation caused an increase in the magnitude of the electric pulses, but no change in the number of pulses for a given ultra-violet illumination. A temporary increase in sensitivity was caused also for α-particles which were used as a control in the experiments; the sensitivity towards light, after a slight initial fall from the first high level reached by irradiation with γ-rays, remained at an increased value of the order of twice the initial sensitivity.

Meyer presented a paper on a proportional Geiger–Müller counter to be used for energy measurements of ionizing particles. The volume of this counter is sufficient to ensure that the particle comes to a complete stop inside the measuring volume. The calibration procedure is ingenious: a window is arranged on the side of the counter, with an electrode outside supplying a field which ensures that the missing part of the wall is at the same potential as the wall itself. In the calibration procedure, α-particles are allowed to pass across the gap in the wall, outside the counter; the central part of their path supplies a known number of ions within the counter. The ionization of the particles to be measured is easily determined by an arrangement of two gas-filled relays connected in opposition and working together into a mechanical counter. Particles of low energy will not affect any of the relays. With particles of increasing energy, one of the relays will operate and work the mechanical counter; with even faster particles both relays will operate, and since they are connected in opposition on the output side, the counter will not respond. The combination of relays thus constitutes an 'energy slit' which can be moved through the energy spectrum merely by altering the grid-bias voltages of both relays.

The age of the earth was discussed by Houtermans. His considerations were based on the relative prevalence of various isotopes of lead, with atomic weights of 206, 208 and 209, originating from U^{238}, Th^{232}, and U^{235} respectively. On this basis, the age of the earth

comes to $2 \cdot 9 \times 10^9$ years, with an accuracy of $\pm 0 \cdot 3 \times 10^9$. This is in good agreement with results by Koszy and Wefelmayer based on the total amount of lead present in the earth's crust.

The data underlying these considerations were obtained by means of the semi-routine mass spectrometer developed at Göttingen by Kopfermann. It was claimed that this instrument is much more simple in use and cheaper than any at present available or described. Commercial production of it is contemplated if conditions permit. The success of the instrument is largely due to the principle of producing the ionized particles by electrons oscillating up to a hundred times in the ion gun. In this way a high degree of ionization, often up to 90 per cent, is achieved, and a mass spectrum in the form of a cathode-ray oscillogram can be obtained with very small amounts of substances.

Another instrument demonstrated was a small mass spectrograph used for isotope separation. Amounts up to 0·5 mgm. of certain isotopes can be obtained in twenty-four hours, which is often sufficient for biological experiments with tracer elements. The results of such experiments were investigated by means of the mass spectrometer mentioned above. This collaboration between physicists and biologists is at present impeded by zone boundaries and other difficulties, but is regarded as a very promising line of research.

Similar collaboration between physicists and biologists has centred around the electron miscroscope. This instrument is not fully occupied by problems arising in the physics departments alone, but is now being fully utilized in collaboration of this kind.

From R. W. Pohl's laboratory, Mollwo reported on the density of vacuum-deposited salt layers. An elegant micro-balance was made up from the parts of a moving-coil instrument, the current through this instrument being used to counteract the increase in weight of the support of the salt layer. Precautions are necessary to eliminate the effect of stray electrical charges; when this is done, the sensitivity of the method is considerable. The thickness of the deposited layers is determined by an interference method best described as a reversed Lummer–Gehrke system: the light falls on the layer at glancing incidence, and the interference fringes formed become visible due to any scattering particles present in or on the surface under investigation. All measurements are carried out in the same vessel in which the layer is deposited, without disturbing the vacuum. Applying these methods to layers of magnesium oxide, it was found that the density of the deposited layer is lower than that of the solid. The porosity of such layers was demonstrated by breathing on them, when the interference fringes shift. It was worthy of note that coherent layers of magnesium oxide could not be formed unless a very small amount of a nucleating material was first deposited on to the support. For this purpose, metallic copper was found most useful.

This porosity is of interest in connexion with other investigations on the secondary photo-electric conductivity in magnesium oxide. The permanent secondary conductivity, caused by illumination with light of the appropriate wave-length, is connected with a chemical reaction characterized by the release of oxygen. Mass action considerations apply; that is, the reaction can be impeded by increasing the external oxygen pressure.

König reported on other work on the structure of thin evaporated layers, as investigated by electron and X-ray diffraction. For years now there has been an argument about the lattice constants of the very small crystals first formed on deposition *in vacuo*, various authors reporting differences between small and large crystals of the order of 6 per cent. It was now demonstrated that these discrepancies are due to faulty calibrations of the electron diffraction apparatus, which in many instances was carried out using gold leaf, assuming this to be pure gold. Gold leaf actually contains up to 5 per cent copper, apart from other impurities. Using a twin diffraction camera giving simultaneously the pattern due to a calibration substance and that under test, it was shown that there are no discrepancies between the lattice constants of small and large crystals. Experiments have been done with silver, gold, copper, iron, germanium, zinc oxide, copper oxide, potassium bromide and lithium fluoride; the accuracy of the electron diffraction experiments was stated to be one per mille in terms of the lattice constants.

Another investigation by König dealt with the size of the crystallites necessary for ferro-magnetism. Very small iron crystals were obtained by vacuum deposition on to a cooled surface. The size of the crystals could be controlled by the temperature of the receiving surface. The magnetization was measured in the same apparatus, without disturbing the vacuum, by determining the magnetic Faraday effect of the layer; the size was found by electron diffraction methods. Two results of considerable interest were obtained. The smallest crystal which still exhibits ferro-magnetism consists of about 64 atoms. This is thought to indicate that it is necessary to have one completely 'shielded' unit cell in which the spins can orientate themselves. The other finding concerns the shapes of the smallest crystallites formed by deposition on a surface kept at sufficiently low temperature which appear to consist of unit cells, lying in haphazard orientation in the deposited layer. The process of crystal growth occurring on warming up would then consist in the re-orientation and alignment of unit cells. These results were obtained not only with iron and other metals, but also with ionic crystals.

Justi has made a survey of a large number of elements with respect to their super-conductivity, and has found a few new super-conductors. Super-conductivity of sodium and potassium is not certain; rubidium, cæsium, erbium, silicon, tellurium and molybdenum do not exhibit it. Rhenium becomes superconductive at 0·90° K. and uranium at 1·25° K. Ruthenium was also stated to be a super-conductor. Although Justi confined his considerations to elements, an interesting recent finding by the brothers Farkas was mentioned in the discussion, according to which a solution of sodium in ammonia becomes super-conductive at −100° C.

Heisenberg reported on a new theory of super-conductivity according to which a small proportion of the free electrons in a metal, namely, those near the surface of the Fermi distribution, form below the transition temperature an ordered structure or super-lattice. The distance between the electrons forming this super-lattice will amount to many times the lattice spacing. When this lattice is formed, scattering processes are impossible and a lowest state with current can occur. The theory suggests that all metals can become super-conductors, that the low value of the transition temperature is to a certain extent accidental, and that it is not out of the question that materials may exist for which this temperature is much higher than usual.

N. F. Mott

ANTI-TUBERCULAR COMPOUNDS

By Dr. VINCENT C. BARRY

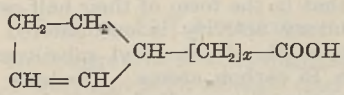
Research Fellow, Medical Research Council of Ireland (Department of Chemistry, University College, Dublin)

IT is not possible in a short article to mention all the types of substances, organic and inorganic in character, active *in vitro*, which have been tested against tuberculosis experimentally induced in animals. One encouraging fact emerges from the early work, however. Certain substances, tuberculocidal or tuberculostatic in character, have been shown to have the power of penetrating the tubercle *in vivo*. It has not been shown, on the other hand, that any substances congregate selectively in tuberculous tissue or that their concentration in this tissue will remain at a high level while falling in the blood. All that can be truly said is that access to the desired site of action of the drug is apparently possible to some substances, although the action of these substances *in vitro* may not be reproduced in the tubercle in the living animal.

In a general way one can postulate the properties which one would expect an effective chemical agent against tuberculosis to possess. It should have the ability (1) to inhibit the tubercle bacillus *in vitro* in high dilution, which presumably implies permeating to some extent at least the bacillary membrane, (2) to circulate freely in the blood for a very long period without injury to the host, (3) to pass from the blood stream, where tubercle bacilli are not found, to tuberculous tissue, and (4) to penetrate finally the tubercle, which, although presumably a defensive line of the body, nevertheless serves as a protection for the bacilli also. It will be noticed that *in vitro* activity of the agent has been put as the first critical requirement. That has been done not in the belief that a substance active in the test tube will necessarily retain its activity in the animal, or that a substance inactive in the test tube and possibly insoluble in ordinary media will inevitably be inactive in the animal. The organic chemist, however, attempting to produce a chemotherapeutic agent for tuberculosis, must have a simple and moderately quick test at his disposal in order that he may know that he is working along lines that have a reasonable chance of achieving success. The evaluation of a substance in an animal (the guinea pig for choice) is expensive in time and in materials, and is out of the question for most investigators until a substance is produced which has been judged promising on other grounds.

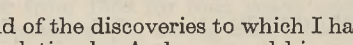
Of the earlier attempts at the chemotherapy of tuberculosis, as for example metal therapy or the use of antiseptics, it is not possible to predict that they may not yet prove successful in a modified form. Since these substances are inactivated by the presence of blood, the odds appear, however, to be all against them. Neither would it be safe to predict that an antibiotic substance may not be found which, unlike streptomycin, would achieve a complete disinfection of the animal body. It is more heartening, nevertheless, for the investigator to design his attack on the bacillus on the basis of a theory which relates to a fundamental circumstance, for example, in the metabolic processes or chemical composition of the tubercle bacillus.

One fundamental approach to this problem was based on fatty acids with branched-chains. The interest in this type of compound derives from two unrelated discoveries. The first of these was the final elucidation by Adams and his colleagues of the structure of chaulmoogric and hydnocarpic acids. These acids are obtained from chaulmoogra oil, which has been used for centuries in the East for the treatment of leprosy, and the leprosy bacillus is, of course, related to the tubercle bacillus.



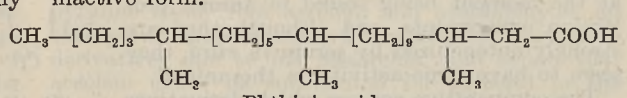
Chaulmoogric acid $x = 12$; Hydnocarpic acid, $x = 10$.

The second of the discoveries to which I have referred was the isolation by Anderson and his co-workers of a number of liquid saturated acids from the lipoid fraction of the tubercle and other acid-fast bacilli[1]. Two of these acids were thoroughly examined and were shown to be unique at the time among naturally occurring fatty acids, in that they possessed a branched-chain, and one of them—tuberculostearic acid—an odd number of carbon atoms.



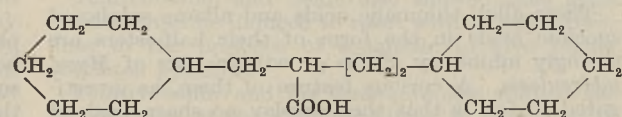
10-Methyl stearic acid (tuberculostearic acid).

The second acid, phthioic acid, has been the subject of synthetical studies by Robinson and his co-workers[2]. They at first considered it to be ethyl decyl dodecyl acetic acid, a substance which has very striking biological properties producing, on animal injection, cell reactions and tubercle formation very much like phthioic acid itself. As a result of further work, Robinson[3] has returned to the original views in a modified form of the American workers. It is now believed to be 3 : 13 : 19-trimethyl tricosanoic acid, which has been synthesised in an inactive form.



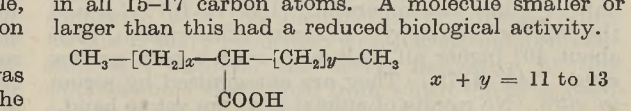
Phthioic acid.

A very large number of acids, mostly of the di-substituted acetic acid type, was synthesized in Adams's laboratory and tested against various Mycobacteria[4]. It was shown that the cyclopentenyl ring in chaulmoogric acid fulfilled the function of a branched-chain. ω-Cyclohexyl aliphatic acids had maximum activity when the molecule contained 14–17 carbon atoms. Greater activity was found when the carboxyl group was in or near the centre of the molecule. The most effective of these acids against the tubercle bacillus *in vitro* was :

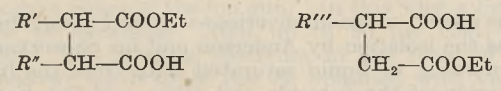


Inhibitory dilution, 1/50,000 *v. Myco. tuberculosis.*

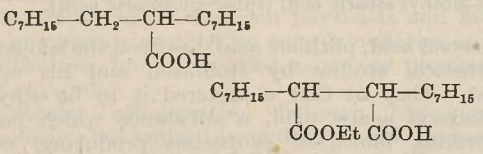
In further synthesis, the ring structure was dispensed with and dialkyl acetic acids were prepared, which were most active when the —COOH was near the centre of the chain and when the molecule contained in all 15–17 carbon atoms. A molecule smaller or larger than this had a reduced biological activity.



Our own synthetical approach started with roccellic acid (α-methyl-α′-*n*-dodecyl succinic acid), which was isolated from the lichen, *Lecanora sordida*. We have already reported[5] that this substance, in the form of its half-esters or half-amides, inhibits completely the growth of the tubercle bacillus *in vitro* at a dilution of about 1/500,000. From an examination of a series of dialkyl succinic acids, it is now clear that in the form of their half-esters, maximum inhibitory activity is encountered when the total chain-length of the alkyl substituents ranges from 13 to 15 carbon atoms. We have since synthesized a series of monoalkyl (C_6–C_{18}) succinic acids

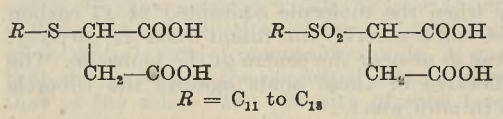


and shown that the same pattern repeats itself, maximum biological activity being encountered when the alkyl group contains 13–15 carbons[6]. From the point of view of *in vitro* activity, therefore, dialkyl succinic acids have no advantage over monoalkyl acids. It is remarkable, however, that the half-ester



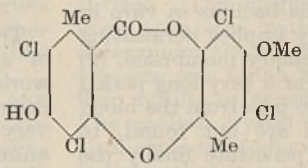
of α-α′-di-*n*-heptyl succinic acid, which differs from heptyl octyl acetic acid only in the possession of an extra carbethoxy group, should be ten times as inhibitory as the latter of the growth of the tubercle bacillus *in vitro*. The most active of these compounds are at the moment being tested in animal protection experiments, and although they are strongly antagonized by serum *in vitro*, they seem to have some activity in the animal.

The comparative success which derivatives of diamino-diphenyl sulphone have met with in experimental tuberculosis in guinea pigs[7] suggested the synthesis of a new series of compounds which would contain a sulphone group, while yet retaining to some extent the essential structure of the succinic acid derivatives.

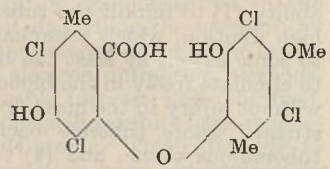


These alkyl thiomalic acids and alkane sulphonyl succinic acids in the form of their half-esters are strongly inhibitory of the growth *in vitro* of *Myco. tuberculosis*. A curious feature of them, as investigated so far, is that they display no sharp peak of activity against mycobacteria, as the chain-length of *R* is increased. From *R* = C_{11} to C_{18} the inhibitory dilution of both series of compounds remains more or less constant. This may be related to another peculiar feature which they possess. The alkylthiomalic acids (*R* = C_9 to C_{18}) all melt over a very narrow range of temperature (103° to 107° C.), and the alkane sulphonyl succinic acids which melt about 40° higher all melt also over a very narrow range (142°–147°). They are antagonized by serum *in vitro*. No results of animal tests are yet to hand.

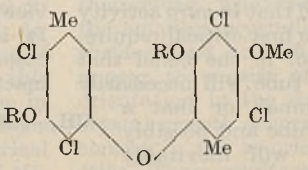
Compounds of a completely different type are also being investigated in this laboratory. As already reported[8], diploicin when rendered soluble in aqueous media by a slight alteration in its molecule completely inhibits the growth of the tubercle bacillus *in vitro* at a dilution of 1/100,000, and the diphtheria bacillus at 1/70,000. The carboxyl derivative *A* is easily soluble in neutral solution, but readily loses carbon dioxide to form *B*. Both *A* and *B* are active *in vitro*, but *B* is too insoluble for animal injection. *C*, *D* and *E* are modifications of the molecule made with the view of increasing solubility while preserving antibacterial power. The —COOH in *D* is stabilized by methylation of the hydroxyl in the *para*-position, but its activity is reduced very considerably. It was hoped that in *E*, solubility would be restored by hydroxyethylation while at the same time conserving the stability of the —COOH group. This compound, however, has very poor antitubercular power. *C* is also quite inactive, and it seems probable that a free phenolic hydroxyl group is necessary in each ring. The balance is clearly a delicate one, and the minimum clothing necessary for a halogenated diphenyl ether to have antitubercular properties will need to be arrived at from the synthetic end.



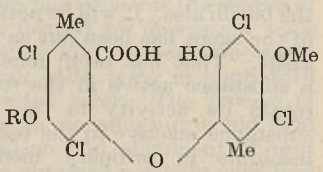
Diploicin



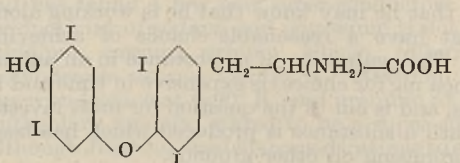
A : Active



B. (*R* = H) Active
C. (*R* = —CH_2.COOH) Inactive



D. (*R* = CH_3) Reduced activity
E. (*R* = —C_2H_4OH) Inactive



Thyroxine

The only known substance of the halogenated phenyl ether type, occurring normally in the animal body, is thyroxine, and its resemblance to diploicin suggested to the author that hyperactivity of the thyroid gland, resulting in excessive secretion of thyroxine, might provide a defence against the spread of tubercular infection in the animal body. Since this hypothesis was published[8], a report has appeared in the literature from Izzo and Cicardo[9], claiming that injection of thyroxine into guinea pigs infected with tuberculosis has produced a considerable prolongation of life over untreated animals, and that thyroidectomized guinea pigs show a very much reduced resistance to tuberculosis. It is not suggested that treatment with thyroxine is ever likely to be used as a protection against or cure for tuberculosis. Further

work in this direction may, however, yield pointers of value to workers on the chemotherapy of tuberculosis.

[1] Anderson and Chargaff, *J. Biol. Chem.*, **85**, 77 **83**, 169 (1929).
[2] Robinson and Birch, *J. Chem. Soc.*, 505 (1940).
[3] Polgar and Robinson, *J. Chem. Soc.*, 389 (1945).
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OBITUARIES

Prof. E. H. Lamb

Ernest Horace Lamb was born at Adelaide on May 5, 1878. He left Australia for Great Britain when his father, the distinguished mathematician, Horace Lamb, was appointed to a chair at Owens College, Manchester. After attending Manchester Grammar School, Ernest had a distinguished career at Owens College (now Victoria University of Manchester). He gained his practical experience with Mather & Platt, Ltd., Manchester, and was afterwards employed by W. H. Allen, Sons & Co., Ltd., Bedford. In 1913 he was appointed professor of civil and mechanical engineering at East London College (now Queen Mary College), University of London.

Lamb served with distinction during the First World War, first with the Royal Marines and later with the R.N.V.R. After service throughout the Gallipoli campaign, when he was awarded the Distinguished Service Cross, he went to H.M.S. *Vernon*, at Portsmouth, where during 1917–19 he was in charge of experimental work and special designs for naval mining appliances.

When Lamb returned to Queen Mary College after the War, he played an active part in the development of the engineering studies of the College, and of the University of London. He was dean of the Faculty of Engineering of the University during 1924–28, and a member of the Senate of the University during 1929–34. He was dean of the College Faculty of Engineering, served on the governing body, and was appointed vice-principal of the College.

Ernest Lamb inherited his father's mathematical ability, and contributed papers on various engineering subjects to the engineering institutions and to the technical Press. He was a member of the Institution of Mechanical Engineers; and an associate member of the Institution of Civil Engineers, of which he was awarded the Telford Gold Medal.

With all his gifts and extraordinary ability, Lamb was devoid of any personal ambition. To all his many duties he brought a freshness of outlook, a capacity for work, and a sense of humour that endeared him to all his colleagues. He gave freely to help all around him, but preferred to remain himself in the background. For this reason his work, both scientific and administrative, was not so well known as it deserved to be, and it was only those who knew him best who appreciated just how much he contributed to the welfare of Queen Mary College.

At the outbreak of war in 1939, the College was moved to Cambridge, and, although Prof. Lamb reached retiring age in 1943, he carried on until the end of the War. He retired in 1945, being later appointed professor emeritus. He continued to live in Cambridge, where his many friends hoped he would be active for many years. He was looking forward to carrying on with work for which his College duties had not given time.

His many friends were shocked to learn that Prof. Lamb died suddenly of heart failure on October 12.

E. Giffen

Prof. A. E. Tchitchibabin

Alexej Eugenievitsch Tchitchibabin, born at Kusemino, Poltava, in 1871, recently died in Paris at the age of seventy-four. He studied at the University of Moscow from 1888 for four years, and published his first scientific paper during that period. His work was on pyridine and its derivatives, a field then neither well known nor very popular; but in spite of opposition, he persisted with it and never lost interest in the field.

In 1902, he was made 'Magister Chimia' in the University of Moscow as a result of a thesis on the action of alkyl halides on pyridine and quinoline, and afterwards gained the rare honour of doctor of chemistry of the University of St. Petersburg; six years later he was appointed professor of organic chemistry at the Imperial College of Technology (Moscow), becoming dean of the College in 1909. In 1918 he was in addition professor of chemistry in the University of Moscow. During the First World War, Tchitchibabin undertook the organisation of the Russian pharmaceutical industry and, largely due to his work, his country became substantially independent of German supplies. In 1931, Tchitchibabin moved to Paris and directed the laboratory of the Collège de France.

Most of Tchitchibabin's two hundred or so publications are concerned with pyridine and its derivatives; among other things he synthesized pyridine itself from acrolein and acetaldehyde, an example of a general method for synthesis of pyridine derivatives due to his researches, and found that acrolein could be substituted for glycerol in the Skraup quinoline synthesis. In 1913, with his coworker Seide, he made one of those rare discoveries in chemistry—an entirely new reaction by which 2- and 4-aminopyridines could be obtained by the action of sodamide on pyridine. This reaction, he showed, takes place in two stages, the intermediate sodamidopyridine being decomposed by water. This remarkable discovery was not at first appreciated by chemists outside Russia, due possibly to the fact that it was published in Russian; but, as is shown later, had very important industrial and academic implications in due course.

Tchitchibabin and Seide also showed that alkyl halides could be induced to react with α- and γ-picolines in the presence of sodamide to give higher alkylated pyridines.

Tchitchibabin and his assistants also studied the tautomerism of the aminopyridines, in particular of 2-aminopyridine, which like 4-aminopyridine and unlike 3-aminopyridine is not a true amino compound, and which cannot be diazotized and coupled to give azo dyestuffs.

2-Aminopyridine has been manufactured in large quantities by Tchitchibabin and Seide's method in connexion with the manufacture of sulphapyridine (M and B 693); condensed with *p*-acetamidobenzenesulphonyl chloride, the acetyl derivative of this sulphonamide is obtained from which the drug itself can be prepared by alkaline hydrolysis.

As a result of the work on sulphapyridine, 2-aminopyridine has now become available in large quantities as an intermediate with a large potential value in the laboratory and in industry.

In 1924, Tchitchibabin published his work, "Fundamental Principles of Organic Chemistry" (translated into French); this work is dedicated to his only child, his daughter Natacha, who was tragically killed in an accident in a chemical factory. Tchitchibabin's wife, Vera Vladmirovna, was also a scientific worker. M. A. PHILLIPS

WE regret to announce the following deaths:

Dr. Harry Roberts, well known as a writer on social medicine and related topics, on November 12, aged seventy-five.

Prof. F. M. Rowe, F.R.S., professor of colour chemistry and dyeing in the University of Leeds, on December 8, aged fifty-five.

Mr. J. D. Watson, formerly engineer to the Birmingham, Tame and Rea Drainage Board, and a past-president of the Institution of Civil Engineers, on November 23, aged eighty-six.

NEWS and VIEWS

Plumian Chair in the University of Cambridge
Prof. H. Jeffreys, F.R.S.

PROF. HAROLD JEFFREYS, who has recently been elected to the Plumian professorship of astronomy and experimental philosophy in the University of Cambridge, in succession to the late Sir Arthur Eddington, is a theoretical geophysicist of world-wide repute. He has been a fellow of St. John's College, Cambridge, since 1914, and a fellow of the Royal Society since 1925. During the First World War, and for several years afterwards, he was at the Meteorological Office, and following a period of some years as a lecturer at his own College he was appointed reader in geophysics in the University of Cambridge in 1931. He is perhaps best known as a seismologist, but as evidence of his versatility it may be mentioned that, in addition to gaining the Adams Prize in 1927, he has been awarded the Buchan Prize by the Royal Meteorological Society (1929), the Gold Medal of the Royal Astronomical Society (1937) and the Murchison Medal of the Geological Society (1939). He has written extensively on probability, notably in relation to significance tests, and an axiomatic exposition of the theory is set out in his book on the "Theory of Probability", to which his earlier book, "Scientific Inference", makes a suitable introduction. His books on Cartesian tensors and on operational methods have been a stimulus to the use of these techniques. The best-known work of Prof. Jeffreys is undoubtedly "The Earth", and it may fairly be said that this treatise, much of it his own researches, welded together a number of scattered topics into a coherent subject. It was indeed felicitous that he dedicated this work in 1924 to a former Plumian professor, Sir George Howard Darwin, "The Founder of Modern Geophysics".

Crystallography at University College, London
Dr. Kathleen Lonsdale, F.R.S.

A READERSHIP in crystallography has been established in association with the Department of Chemistry of University College, London, and Dr. Kathleen Lonsdale has been appointed to the post. This marks the first major step in the creation of a new university centre for the training of crystallographers and crystallographic research workers. Dr. Lonsdale, who received her university education at Bedford College, London, distinguishing herself in physics and mathematics, obtained her research training at the Royal Institution under the late Sir William Bragg, whose research assistant she eventually became. Except for two years as Amy Lady Tate Fellow in the University of Leeds, and for short periods covering the infancy of her children, Dr. Lonsdale has, since graduation, been associated with the Royal Institution, latterly as Dewar Fellow, and during the past twenty years as one of the most notable contributors to its distinguished record of research. She was one of the first two women to be elected to the fellowship of the Royal Society.

Dr. Lonsdale has taken a leading part in the development of modern experimental and mathematical methods in the X-ray analysis of crystals. She pioneered the determination of molecular structure by Fourier analysis of X-ray patterns, and was the first to establish the size and shape of the benzene ring in hexamethyl benzene and hexachlorobenzene. She took a leading part in the establishment of magnetic anisotropy and its molecular significance in aromatic crystals. She has shown how the thermal vibrations, and hence the elastic forces, in crystals can be investigated by means of the diffuse X-ray reflexions, which had not been previously understood. She has recently been developing the divergent beam method of X-ray analysis, and the study of crystal texture by that method.

Dr. Frans Verdoorn

THE first Mary Soper Pope Medal of the Cranbrook Institute of Science, Michigan, has been awarded to Dr. Frans Verdoorn, editor of *Chronica Botanica*, in recognition of his editorial and international relations work in biology as well as for his researches in cryptogamic botany and the history of the plant sciences. Dr. Verdoorn, who was born in Amsterdam in 1906, went to the United States in 1940. He is managing editor of the Chronica Botanica Co., which publishes *Chronica Botanica*, "A New Series of Plant Science Books", and *Annales Cryptogamici et Phytopathologici*. He is also botanical secretary of the International Union of Biological Sciences and special adviser to the Netherlands Indies Department of Agriculture. His principal books are: "de Frullaniaceis" X–XVIII, "Manual of Bryology", "Manual of Pteridology", "Plants and Plant Science in Latin America", "Science and Scientists in the Netherlands Indies" (with P. Honig), and the "Index Botanicorum", a biographical dictionary of plant scientists, now in preparation in co-operation with the Arnold Arboretum of Harvard University, with which Dr. Verdoorn has been connected since 1941. From 1947 onwards, Dr. Verdoorn will issue a monthly biological news-letter, *Biologia*, and an annual review of progress in international relations and co-operation in science, to be entitled *Pallas*.

Scientific Appointments at the Ministry of Supply

Sir Ben Lockspeiser, director-general of scientific research (air) at the Ministry of Supply, has been appointed chief scientist to the Ministry. This newly created post is a continuation of the co-ordination of the research and development programmes for defence and air resulting from the merger earlier this year of the Ministry of Supply and the Ministry of Aircraft Production. Sir Ben will be responsible in future for co-ordinating research work on the Ministry's military and aeronautical programmes, and for supervising the general interests and welfare of its large scientific staff. He will be assisted in these duties by the Scientific Co-ordinating Board, to which Sir John Lennard-Jones has agreed to continue to act as chairman for the present. The Ministry has also announced that the following four appointments, all at Principal Director level, will be incorporated in its higher organisation for research and development: *Scientific Research (Air)*: Mr. H. M. Garner, who has held a number of posts in the scientific departments of the Air Ministry, Ministry of Aircraft Production and Ministry of Supply since his entry into Government service soon after the First World War; between 1942 and 1945 he was deputy director of scientific research in the Ministry of Aircraft Production. *Technical Development (Defence)*: Mr. T. R. B. Sanders, who served with the Royal Artillery in the early part of the War, later becoming assistant chief engineer of armaments design in the Ministry of Supply. *Scientific Research (Defence)*: Dr. E. T. Paris, who joined the Ministry of Supply upon its formation in 1939, previously having been deputy director of scientific research at the War Office; prior to taking up his present appointment he was controller of physical and signal development in the Ministry of Supply, being responsible (under the Director-General of Scientific Research and Development) for all Army signals and radar development. *Technical Development (Air)*: Mr. S. Scott-Hall, who from 1944 until taking up his present post was superintendent of performance testing at the Aeroplane and Armaments Experimental Establishment, Boscombe Down, Wiltshire; between 1941 and 1944 he was head of the Armament Research and Development Department of the Royal Aircraft Establishment, Farnborough.

The Ministry of Supply further announces that responsibility for all branches of research and development concerning guided projectiles—including the proposed range in Australia—are to be integrated under the Controller of Supplies (Air). Details of the new organisation will be given in due course.

National Coal Board: Director of Carbonization Research

The National Coal Board announces that Prof. H. L. Riley, professor of inorganic and physical chemistry in the University of Durham, has been appointed director of carbonization research under the scientific member of the Board, Sir Charles Ellis. Prof. Riley studied at the Imperial College of Science and Technology, and took an honours degree in inorganic chemistry; he was awarded the Frank Haddon Prize. He held a Beit Research Fellowship during 1921–23, and remained as lecturer at the Imperial College until he went in 1932 to King's College, University of Durham. Prof. Riley's research work at Newcastle has been devoted to the study of coking problems, and he is recognized as an expert in this field. He is also honorary secretary and director of research to the Northern Coke Research Committee, and is a member of the British Coking Research Association. He is forty-seven years of age.

Chemistry at Chelsea Polytechnic: Dr. J. F. J. Dippy

When Dr. C. Doree retired from the post of head of the Department of Chemistry at the Chelsea Polytechnic in 1940, the vacancy was filled by the promotion of Dr. J. C. Crocker, then first assistant in the Department; Dr. Crocker retired at the end of August. Dr. John F. J. Dippy has now been appointed to the post. Educated at University College, Swansea, Dr. Dippy showed early promise as a research worker, and his work has been well recognized in Great Britain and in the United States. He is an energetic man with interests in both pure and applied chemistry. Beginning with a lectureship in chemistry at the Cardiff Technical College (1930), Dr. Dippy moved to a headship at the Mining and Technical College, Wigan (1942), and is at present head of the Department of Chemistry and Biology at the South-East Essex Technical College, Dagenham (since 1945). He has high academic and administrative ability.

Agricultural Attaché at the British Embassy in Buenos Ayres

Major T. A. Rattray has been appointed agricultural attaché to the British Embassy in Buenos Ayres. Major Rattray, who is fifty-seven, was educated at Winchester. After service in the First World War, he farmed in Shropshire and Somerset until, in 1934, he took up an appointment with the Ministry of Agriculture as a livestock officer. From 1939 onwards Major Rattray has acted as one of the Ministry's land commissioners.

Reports on German Industrial and Scientific Progress

In a written answer to a question regarding reports on German industrial and scientific progress on December 5, the President of the Board of Trade stated that 1,390 such reports have been published to date, 572 by British teams, 278 by American teams and 540 by combined teams, and it is expected that the total would approach 2,500. In addition to placing the reports on sale at H.M. Stationery Office, free distributions of all reports published are made to universities, the principal public libraries and chambers of commerce. Trade and research associations and learned professional institutions also receive a token free distribution of the reports of direct interest to them. Arrangements have been made with the Stationery Office to produce both a classified list of the reports and a subject index, and an Information Bureau and Reference Library has also been created at the secretariat of the British Intelligence Objectives Sub-Committee, which body is now administered by the Board of Trade. This Reference Library contains not only all the finished reports but also much of the raw material on which they were based. The work is closely co-ordinated with the Documents Unit of the Board of Trade, which is the central repository for the large quantity of original German documents collected in the British and allied investigations. The Unit has facilities for translating and abstracting and

for supplying copies of the abstracts or of the original documents to any interested party, and this Information Service, with a nucleus technical staff and access both to the reports and to the original German documents, should be of great assistance to firms with limited research facilities. Publicity is being given to this service and facilities by an exhibition opened at the Board of Trade at Millbank, London, on December 10; the exhibition will eventually be shown in the most important provincial industrial centres of Britain.

Centenary of the Sewing Machine

Sewing needles of bone date back to prehistoric times, and the steel needle made its first appearance in Britain in the sixteenth century. The speed of expert hand-sewing, thirty stitches per minute, is slow and laborious compared with that of machine work, and with the ushering in of the mechanical age in the eighteenth and nineteenth centuries, it is not surprising that the invention and development of the sewing machine should have come about early in this period. A chain-stitch machine with its single thread had already been made by B. Thimmonier, in 1830, and a machine produced by W. Hunt, in 1832–34, had an eye-pointed needle and an oscillating shuttle. It remained for Elias Howe to make and patent, in 1845, the first successful lock-stitch machine, in which an eye-pointed needle and an independent shuttle, each with its own thread, were used. He disposed of his English interests in the patent to William Frederick Thomas, of Cheapside, in whose name the British patent stands, dated December 1, 1846. The Royal Scottish Museum, Edinburgh, is commemorating the occasion of the centenary by holding a small exhibition of sewing machines. Thanks to the generosity of Mr. A. W. Pickard, of Glasgow, the Museum has in its collection one of the first six of the 1846-type machines, which were made by Howe. A number of other machines of dates ranging over the complete century of development are shown. These include early Howe and also Wheeler and Wilson machines, while modern development is illustrated by the latest domestic and workroom models of the Singer Sewing Machine Co.

University of Birmingham

The pro-chancellor of the University of Birmingham, Mr. Edmund P. Beale, is retiring after having held office since 1939. Mr. Beale, whose father was the first vice-chancellor of the University, became a member of the University Council in 1924 and was treasurer from 1930 until 1939. To commemorate his services, Mr. Beale has been presented with a portrait of himself, painted by Mr. A. Middleton Todd. The chancellor of the University, Mr. Anthony Eden, who made the presentation on behalf of the subscribers, paid a warm tribute to the work done by Mr. and Mrs. Beale for the University. The success of the recent appeal for funds, in response to which more than £1,000,000 has already been subscribed towards the £1,500,000 asked for, owes much to Mr. Beale's personal efforts. The vice-chancellor, Dr. Raymond Priestley, said that when he came to Birmingham he was somewhat prejudiced both against a lay element in a university council and lay honorary officers; but he now believes it to be the best possible system for a university like that of Birmingham. Mr. Beale, he said, typified integrity, loyalty and grit, and "one who can appreciate—as not all laymen do—academic standards and ideals. He has stood for a university of national and international standards both of teaching and research."

The newly formed Department of Chemical Engineering in the University of Birmingham is giving special attention to the problems of fuel technology and the utilization of coal. On the occasion of a recent visit of more than a hundred executives of the gas and allied industries, the vice-chancellor emphasized the importance of making the best possible use of our remaining supplies of coal and high-grade iron ore. "We must capitalize," Dr. Priestley said, "our best brains, our national skill, and the faculty for the co-ordination of hand and brain in which, as a people, we are endowed, I believe, beyond most others, and it is in these fields that this university plans to help."

Organisation for the Interchange of Technical Publications in Sheffield

A report on the war-time work of the Organisation for the Interchange of Technical Publications in Sheffield was presented to the annual general meeting held in the Sheffield Central Library on November 5. This Organisation provides the framework for a system of co-operation between the Sheffield City Libraries, the University Library and other research libraries in the area, and the libraries maintained by local firms. Through its agency any member library, research workers employed by member firms, or accredited students at the constituent libraries, can draw on the pooled resources of the twenty-nine libraries included in the Organisation. Some of the member libraries are of such a highly specialized nature and cover so small a field (although in minute detail) that they rely largely on the extensive resources of the Science and Technology Department of the City Library in matters outside the range of their own material. Hence, as the largest contributor to the pool, the tasks of administering the scheme and of preparing research bibliographies on specific aspects of research (a service not, however, confined to members of the Organisation) fall on the City Libraries. The close collaboration between the highly specialized works libraries and research staffs and the City Library allows the latter to benefit from the advice of experts in the selection of books and in the preparation of its research publications. From the beginning of the War until November 1946, 8,163 books, periodicals, etc., were recorded as being interchanged by members, but the actual figures of loans were much higher.

At the annual general meeting, applications for membership from the Bragg Laboratory of the Admiralty, the Davy and United Engineering Company, Hall and Pickles, Ltd., Edward Pryor and Son, Ltd., and the Sheffield and District Gas Company were approved, bringing the total number to six society and twenty-three works members. It was also decided to investigate the possibility of obtaining research services in foreign patents through the Fédération Internationale de Documentation at The Hague. Resolutions were passed asking the Association of Special Libraries and Information Bureaux to urge the Patent Office to publish indexes and abridgments to British patent specifications of the war years, and to make representations to the appropriate Government department on the desirability of providing a national loan service of standards specifications from all countries.

BRITISH PAPER AND BOARD INDUSTRY RESEARCH ASSOCIATION

The Laboratories of the above Association situated at Kenley, Surrey, are nearing completion, and appointment of initial staff is under consideration. Applications are invited for the following posts. Successful applicants will be expected to commence work early in 1947. All appointments are superannuated under the F.S.S.U. All posts are permanent and progressive.

(1) Lady Librarian (age 30-45). Experienced. The work will include organizing the library covering paper and board manufacture, physics, chemistry, engineering, and patents. It will also include the inauguration of an information service to members, and the supervision of abstraction, coordination, and translation of literature, particularly on the research and development of paper and its application in industry in this country and other countries. Good knowledge of languages and scientific qualifications are essential. Salary £375 per annum.

(2) Three Research Officers, namely, Physicist, Physical Chemist, and Chemist (age 30-40). First-class academic qualifications and ability to initiate and carry out research on fundamental principles and applied problems arising from the industry required. Some knowledge and experience of paper manufacture desirable. Salary £750 per annum.

(3) Assistant Research Officer (age 27-35). Good academic qualifications. Able to carry out investigations on testing methods and other researches for application to the industry required. Salary £500 per annum.

(4) Laboratory Assistants (age 25-30). Several years' previous laboratory experience, preferably in the paper or allied industries, and holding Inter.B.Sc., recognized diploma or equivalent. Salary £340 per annum.

Written applications only, with full details of qualifications and experience, to the Director, the British Paper and Board Industry Research Association, St. Winifred's Laboratories, Welcomes Road, Kenley, Surrey.

CITY OF LIVERPOOL

DEPUTY CHIEF LABORATORY TECHNICIAN

SENIOR LABORATORY TECHNICIAN

Applications are invited for the above appointments in the Department of Pathology at Broadgreen Hospital, Edge Lane Drive, Liverpool, 14.

Deputy Chief Laboratory Technician. Salary at the rate of £360 per annum, rising by annual increments of £15 to £405 per annum. Candidates should have had considerable experience in laboratory work and should preferably possess the qualification of the I.M.L.T. or a degree.

Senior Laboratory Technician. Salary between £230 per annum and £350 per annum, according to qualifications and experience. Experience in histology, though not essential, is desirable.

In both cases cost-of-living bonus is payable in addition to the salary stated at the rate of £59 16s. per annum for males and £48 2s. per annum for females. Further particulars as to the duties and scope of the laboratory work can be obtained from the Medical Superintendent of the hospital.

Applications, upon forms obtainable from the Medical Officer of Health, Hospitals Department, Gordon House, Belmont Grove, Liverpool, 6, to be endorsed "Laboratory Technicians," and returned to the undersigned not later than Tuesday, December 31, 1946. Applicants should state clearly the position for which they are applying.

W. H. BAINES,
Town Clerk.

Municipal Buildings,
Liverpool, 2.

CITY OF BIRMINGHAM

Selly Oak Hospital

CHIEF LABORATORY TECHNICIAN

Applications are invited for the post of Chief Laboratory Technician, Selly Oak Hospital, with salary within the range of the Joint Committee on Salaries and Wages (Hospital Staffs), £500 by £25 to £550 per annum. Possession of the Fellowship of the Institute of Laboratory Technology will be of advantage. Including the Biochemical Department, the total number of assistant technicians is eleven.

The appointment will be subject to the provisions of the Local Government Superannuation Act, 1937, and the candidate will be required to pass a medical examination. The post will be subject to one month's notice on either side. Further particulars of the appointment may be obtained from the Medical Superintendent of the hospital.

Applications, stating age, qualifications, and experience, and enclosing copies of three testimonials, should be forwarded to the Medical Superintendent, Selly Oak Hospital, as soon as possible.

CITY OF LEEDS

Public Health Department

DEPUTY CITY ANALYST

Applications are invited for the post of Deputy to the City Analyst under the Leeds Corporation. The person appointed will be required to devote the whole of his time to the work, under the direction of the City Analyst, and will not be allowed to engage in private practice. Applicants must hold the qualification F.R.I.C. (Branch E).

Salary £700 per annum, rising subject to satisfactory service to a maximum of £800 per annum. A cost-of-living bonus (at present amounting to £59 16s. per annum) is also payable.

Subject to the approval of the Ministry of Health and the Ministry of Agriculture, the person appointed will be called upon to act as Additional Public Analyst and Deputy Agricultural Analyst. He will be required to pass a medical examination and to contribute to the Superannuation Fund established under the Local Government and Other Officers Superannuation Act, 1937. The appointment will be subject to termination by three months' notice on either side.

Applications, giving details of age, qualifications, and experience, together with copies of not more than three testimonials, and endorsed "Deputy City Analyst," must be delivered at my office not later than 10 a.m. Friday, January 3, 1947. Canvassing in any form, either directly or indirectly, will be a disqualification.

J. JOHNSTONE JERVIS,
Medical Officer of Health.

NATIONAL MILK TESTING SERVICE

Applications are invited for the following posts in a temporary capacity in the Bristol province under the Ministry of Agriculture and Fisheries:

Provincial Supervisor to exercise general supervision of the service in the province. Applicants should possess a degree in science or the equivalent and should have had sound training in dairy bacteriology and experience in dairying. Salary scales are as follows: Men £300-£400 per annum, women £240-£320 per annum. A consolidation addition is also payable.

Area Supervisor to supervise the work of the service in Somerset. Applicants should possess a degree in science or N.D.D. and should have experience in dairy bacteriology and dairying. Salary scales are as follows: Men £200-£300 per annum, women £200-£275 per annum. A consolidation addition is also payable.

Further particulars of the above posts can be obtained from the Advisory Bacteriologist, 22, Berkeley Square, Bristol, 8, to whom applications should be forwarded not later than December 31, 1946.

RESEARCH BOARD FOR THE CORRELATION OF MEDICAL SCIENCE AND PHYSICAL EDUCATION

RESEARCH PRIZE, 1948

A First Prize of £250, a Second Prize of £50, will be offered in 1948 for a Thesis embodying Original Research on some aspects of the following field of inquiry: The Predisposing Factors in the Development of Chronic Rheumatic Conditions in Early Adult Life.

Entrants for this Research Prize should be either of British nationality or ordinarily resident in the British Empire. Five typewritten copies of the Thesis should be submitted to the Research Board by September 30, 1948. To ensure that the Thesis falls within the relevant field of inquiry, candidates should previously submit for the approval of the Research Board a statement of the nature of their proposed investigation.

Further information and suggestions can be obtained from the Secretary of the Research Board for the Correlation of Medical Science and Physical Education, Apothecaries' Hall, Black Friars Lane, Queen Victoria Street, London, E.C.4.

ROYAL INSTITUTION

AWARD OF GRADUATE MEMBERSHIPS

Notice is given that the Managers of the Royal Institution will shortly proceed to award three Graduate Memberships of the Institution for the year 1947. Graduates of either sex, of any university of the British Empire, who have graduated during 1946 with first- or second-class honours in any scientific subject, are eligible for these awards. The Memberships entitle the holders to the full privileges of the Institution for a period of three years, except that of voting at meetings of the Members.

Full particulars and forms of application can be obtained from the General Secretary, Royal Institution, 21, Albemarle Street, London, W.1. Completed applications must be received by January 15, 1947.

ROYAL VETERINARY COLLEGE AND HOSPITAL

Applications are invited for the post of Lecturer in the Department of Animal Husbandry from candidates who are members of the Royal College of Veterinary Surgeons. Some experience of general veterinary practice, especially among farm animals, is desirable. Salary will be on the scale £500 a year, rising by annual increments of £25 to £850 a year, together with benefits under the Federated Superannuation System for Universities. Pay of the appointee will be fixed within this scale according to age, experience, and qualifications. Applications, giving the names of three persons to whom reference may be made, should be sent not later than January 11, 1947, to the Bursar and Secretary, Royal Veterinary College and Hospital, Royal College Street, London, N.W.1.

ROYAL VETERINARY COLLEGE AND HOSPITAL

Applications are invited for the post of Lecturer in Biochemistry in the Department of Animal Husbandry. Preference will be given to candidates with experience of work relating to animal nutrition. Salary will be on the scale £500 a year, rising by annual increments of £25 to £850 a year, together with benefits under the Federated Superannuation System for Universities. Pay of the appointee will be fixed within this scale according to age, experience, and qualifications. Applications, giving the names of three persons to whom reference may be made, should be sent not later than January 11, 1947, to the Bursar and Secretary, Royal Veterinary College and Hospital, Royal College Street, London, N.W.1.

UNION OF SOUTH AFRICA

FISHERIES RESEARCH

Applications are invited for the post of Director of the South African Fisheries Research Institute in Cape Town, to be responsible for the administration and management of the Institute under a Board of Control, and to direct the research programme. The minimum qualifications required are a university degree, plus a knowledge of the fishing industry and of the technology of the processing of fish products, together with administrative experience. The salary scale is £1,200-£1,500.

Applicants are requested to write in the first instance to the Scientific Liaison Officer, South Africa House, Trafalgar Square, London, W.C.2, for further information and application forms, which list the details required.

UNIVERSITY OF DURHAM

King's College, Newcastle-upon-Tyne

The Council of King's College invite applications for the post of Lecturer in Mechanical Engineering. There are two vacancies and the persons appointed will be required to take up duty as early as possible in the Epiphany Term, which commences on January 14, 1947.

The salary scale rises by annual increments of £25 to a maximum of £800, and the commencing salaries of the successful applicants (which in any case will not be less than £525) will be fixed at a point on that scale in accordance with qualifications and experience.

Ten copies of application, which should include the names and addresses of three persons to whom reference may be made, should be addressed as soon as possible to the undersigned, from whom further particulars may be obtained.

G. R. HANSON,
Registrar of King's College.

THE WEST OF SCOTLAND AGRICULTURAL COLLEGE

Applications are invited for the post of Research Assistant, Milk Utilization Department, Auchincruive, near Ayr. Candidates should have an honours degree in science, with training in bacteriology and biochemistry and a knowledge of dairying.

Salary scale (Grade IVa) £255 by £25 to £370, plus war bonus addition (£78 at minimum). Entry may be given according to age, qualifications, etc.

Forms of application obtainable from the undersigned should be lodged not later than December 31, 1946.

N. B. BAIN,
Secretary.

6, Blythswood Square,
Glasgow.

UNIVERSITY OF CAMBRIDGE

The Observatory

Applications are invited for the post of Senior Assistant Observer. Salary £500, rising £25 annually to £700, with F.S.S.U. superannuation. Initial appointment for three years.

Application, with a statement of qualifications and the names and addresses of two referees, to be sent to the Director, the Observatory, Cambridge, by January 15.

BRADFORD EDUCATION COMMITTEE

Technical College, Bradford

Applications are invited for the appointment of Assistant Lecturer in Engineering in the College.

Basic salary according to the Burnham scale, which is from £300 to £525 per annum. Commencing salary according to qualifications and experience. The commencing salary may, subject to approval, be increased up to a maximum of ten increments of £15 per annum in respect of approved service in industry.

Further particulars of the appointment and forms of application may be obtained from the Director of Education, Town Hall, Bradford, and completed forms should be returned to the Principal of the College within two weeks from the date of publication of this advertisement.

THOS. BOYCE,
Director of Education.

UNIVERSITY OF ABERDEEN

LECTURESHIP IN STATISTICS

Applications are invited for a Lecturer in Statistics, who will take up duty on April 1, 1947, or as soon thereafter as may be arranged.

Salary £500-£750, according to qualifications and experience. In addition a children's allowance of £50 per annum for the first child and £40 per annum for each subsequent child under 16, or while the child is undergoing full-time education, is payable.

Applications should reach the Secretary to the University (from whom forms of application and conditions of appointment may be obtained) not later than January 15, 1947.

H. J. BUTCHART,
The University, Secretary.
Aberdeen.

UNIVERSITY OF BIRMINGHAM

LECTURESHIP IN MECHANICAL ENGINEERING

Applications are invited for the post of Lecturer (Grade IIb) in Mechanical Engineering. Candidates should have an honours degree in engineering with some practical experience, and a keen interest in research. Commencing salary £600 per annum.

Applications should reach the undersigned (from whom further particulars may be obtained) not later than December 31, 1946. Note: There is no special application form.

C. G. BURTON,
The University, Secretary.
Edmund Street, Birmingham, 3.

BRITISH NON-FERROUS METALS RESEARCH ASSOCIATION

There will shortly be a vacancy for a metallurgist as Chief Officer of the Liaison and Technical Service Department. Candidates, who must be British subjects, should hold a university degree or its equivalent and have had some years' experience in the non-ferrous metals industry. Salary up to £1,000 per annum, depending on age, qualifications, and experience. Applications should reach the Secretary, British Non-ferrous Metals Research Association, 81-91, Euston Street, London, N.W.1, not later than January 11, 1947.

GOUROCK ROPEWORK CO., LTD.

Applications are invited for the position of Chief Chemist to take charge of the Research and Works Laboratories. Responsibilities include direction of original research connected with the processing of all classes of vegetable and synthetic fibres from spinning to finishing, with special reference to dyeing and proofing. Applicants of F.R.I.C. standard must have had good practical experience in textiles. Applications, in confidence, stating age and qualifications, and giving full particulars of experience, to be addressed to the Technical Director, the Gourock Ropework Co., Ltd., Port Glasgow.

THE POLYTECHNIC

309, Regent Street, W.1

A course of six Lectures on Industrial Applications of Rheology will be given by Dr. G. W. Scott Blair on Tuesday evenings from 7 to 8.30, commencing January 14, 1947. Fee 15s.

Detailed syllabus and enrolment form may be obtained on application to the Head of the Department of Mathematics and Physics.

UNIVERSITY COLLEGE OF SWANSEA

The Council of the College invites applications for the posts of Assistant Lecturer in Mathematics, Assistant Lecturer in Physics, and Assistant Lecturer in Chemistry. Present salary in each case £400 per annum.

Further particulars concerning the posts may be obtained from the Registrar, University College, Singleton Park, Swansea, by whom applications must be received on or before December 27, 1946.

ROYAL VETERINARY COLLEGE AND HOSPITAL

Applications are invited for appointment to the Chair of Physiology, which will fall vacant during 1947. The salary will be £1,400 per year and the person appointed will be required to join the Federated Superannuation System for Universities. Closing date for receipt of applications is March 1, 1947. Applications should be forwarded to the Bursar, Royal Veterinary College, Royal College Street, London, N.W.1, from whom further particulars are obtainable.

ROYAL TECHNICAL COLLEGE, GLASGOW

Department of Chemistry

Applications invited for a Grade I Lectureship, salary £450 by £15 to £700. Applicants should possess special qualifications in organic chemistry. Further particulars and form of application may be obtained from the Secretary. Applications to be submitted by January 18, 1947.

UNIVERSITY OF LONDON

The Senate invite applications for the Chair of Mathematics tenable at the Imperial College of Science and Technology (salary £1,500). Applications must be received not later than February 6, 1947, by the Academic Registrar, University of London, Senate House, W.C.1, from whom further particulars should be obtained.

ROYAL TECHNICAL COLLEGE, GLASGOW

POST OF SECRETARY

Applications invited for the post of Secretary (ultimately Secretary-Treasurer). Salary £800 by £25 to £1,050. Superannuation under the Federated Superannuation System for Universities. Applicants must have qualifications and experience in secretarial work, accounts, and finance. Further particulars obtained on application to the Director.

CANTERBURY UNIVERSITY COLLEGE

Christchurch, New Zealand

Applications are invited for the Chair of Electrical Engineering. Salary £1,200 (N.Z.) per annum. Allowance for travelling expenses. Appointment is for three years in the first instance. Further particulars may be obtained from the Secretary, Universities Bureau of the British Empire, 24, Gordon Square, London, W.C.1. Closing date for receipt of applications is January 31, 1947.

CANTERBURY UNIVERSITY COLLEGE

Christchurch, New Zealand

Applications are invited for a Lecturer in Mathematics. Salary £600 (N.Z.), rising to £700 (N.Z.) per annum. Duties to commence as early in 1947 as possible. Special qualifications in mathematical physics will be a recommendation. Further particulars may be obtained from the Secretary, Universities Bureau of the British Empire, 24, Gordon Square, London, W.C.1. Closing date for receipt of applications is January 31, 1947.

AUCKLAND UNIVERSITY COLLEGE

Auckland, New Zealand

Applications are invited for a Lecturer in Architectural Construction. Salary £600 (N.Z.), rising to £700 (N.Z.) per annum. Allowance is made for travelling expenses. Appointment is for three years in the first instance. Further particulars may be obtained from the Secretary, Universities Bureau of the British Empire, 24, Gordon Square, London, W.C.1. Closing date for receipt of applications is January 31, 1947.

THE BEE RESEARCH DEPARTMENT, Rothamsted Experimental Station, Harpenden, have the following posts vacant:

Entomologist to carry out fundamental research on bees. Applicants should possess an honours degree in zoology and should, for preference, have some research experience. The appointment will be in the Scientific Officer class.

Biologist to assist in the research work of the department. This appointment will be in the Experimental Officer class.

The initial salary in each case will depend upon the qualifications and experience of the person appointed. Applications, with full particulars of qualifications, previous experience, etc., together with copies of recent testimonials, should be sent not later than December 31, 1946, to the Secretary, Rothamsted Experimental Station, Harpenden, Hertfordshire, from whom further particulars can be obtained.

REQUIREMENTS:

1. Senior Engineer or Physicist required by research laboratories of large group of companies in High Wycombe area, with wide experience of electronics and radio communications, to take charge of a laboratory engaged on advances circuit design and research. A high standard of mathematical knowledge is required. Men with honours degrees in science are preferred. Initial salary according to qualifications and experience, but in the range of £600-£800 per annum.

2. Senior Engineer required by research laboratories of large group of companies in High Wycombe area, with a wide experience of microwave and radar technique. Men with honours degrees in science are preferred. Initial salary according to qualifications and experience, but in the range of £600-£800 per annum.

3. Senior Engineer or Physicist required by research laboratories of large group of companies in High Wycombe area with a knowledge of acoustics and preferably with experience of the design of loudspeakers and L.F. amplifiers. Men with honours degrees in science are preferred. Initial salary according to qualifications and experience, but in the range of £600-£800 per annum.

4. Research laboratories of large group of companies in High Wycombe area have vacancy for Senior Engineer to take charge of laboratory engaged on the design and development of communication type radio receivers and transmitters. Men with honours degrees in science are preferred. Initial salary according to qualifications and experience, but in the range of £600-£800 per annum.

Apply Box 782, T. G. Scott & Son, Ltd., 9, Arundel Street, London, W.C.2.

THE CIVIL SERVICE COMMISSIONERS invite applications for the post of Principal Scientific Officer in the Radar Research and Development Establishment of the Ministry of Supply, to take charge of mathematical investigations arising in the development of radar and associated equipment.

Candidates must be of British nationality, have been born on or before August 1, 1915, and be not more than fifty years of age on November 1, 1946. They must have a first- or second-class honours degree in mathematics and some research experience in mathematical physics, particularly electro-magnetic theory and/or geometrical optics as applied to radio. Knowledge of electronics and circuit analysis would be desirable.

The post is permanent, with superannuation benefits under the Federated Superannuation System for Universities, and carries salary on the provincial scales, £750 by £30 to £1,020 (men) and £660 by £30 to £880 (women), plus a consolidation addition ranging from £90 at the minimum of the scale to £105 at the maximum (men) and from £79 at the minimum to £84 at the maximum (women).

Further particulars and forms of application are obtainable from the Civil Service Commission, 6, Burlington Gardens, London, W.1, quoting No. 1721, to whom completed applications must be returned not later than January 13, 1947.

A VACANCY EXISTS IN THE RESEARCH laboratories of a commercial firm for a qualified Veterinary Surgeon. The firm is interested in the development of ethical scientific medicines for domestic pets and also for farm animals. The research laboratories are situated in the country, thirty miles from London, and are well equipped for every type of biochemical, bacteriological, and therapeutic research. Adequate animal house accommodation is available and an experimental farm forms part of the installation. Housing accommodation might be found for a suitable candidate. Salary would not be less than £1,000 per annum, and an attractive superannuation scheme is available.

Apply with full details of past experience to Box 781, T. G. Scott & Son, Ltd., 9, Arundel Street, London, W.C.2.

PLANT BREEDER. THE GOVERNING Body of Wye College (University of London) invite applications for the post of Plant Breeder in the Hop Research Department of the College. Practical experience in plant breeding is an essential qualification. The post will carry with it benefits under the F.S.S.U. scheme, and the salary will be according to qualifications and experience, but probably commencing at £610 a year, inclusive. A higher salary would be considered for a man with very wide experience. Further particulars and forms of application obtainable from the Secretary, Wye College, near Ashford, Kent.

ASSISTANT INFORMATION OFFICER REquired. Metallurgical knowledge essential. Age preferably 25-35. Languages an advantage. Salary according to qualifications. Apply as soon as possible to Information Officer, the Iron and Steel Institute, 4, Grosvenor Gardens, London, S.W.1.

(Continued on page ccxx)

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Secondary Electron Photography

Two recent letters in the correspondence columns of *Nature* (Tasker and Towers, **156**, 695; 1945, and Roberts, **157**, 695; 1946) have brought to notice the work of Prof. J. J. Trillat and his colleagues at the Centre National de la Recherche Scientifique, on secondary electron photography. This work, carried out during the war years, is described in a series of notes in the *Comptes Rendus* and the *Revue Scientifique*, Paris, between 1941 and 1945; the fact that it was not referred to earlier is an example of the difficulty of consulting war-time foreign journals. Most of the experiments are concerned with the surface appearances of metal specimens. A low-speed photographic film is placed in contact with the metal surface and irradiated with X-rays of 150–200 kV. The direct effect of the X-rays on the film is small, but the secondary electrons emitted by the metal produce an image of the surface. Differential blackening is produced by metals of different atomic numbers, and with careful control the method is capable of qualitative analysis. Both macroscopic and microscopic photography are possible. For example, a reflexion electron photograph of a magnesium–aluminium alloy containing some manganese, under the microscope shows the distribution of the heavy element around the magnesium–aluminium crystals. This opens up an interesting field in surface metallurgy, with relatively simple apparatus. Alternatively, the secondary electrons from a thin sheet of lead may be used to 'radiograph' very thin objects such as paper or tissue sections. The results are similar to those obtained with very soft X-rays.

Agriculture and the Association of Scientific Workers

The annual conference of the Agricultural Section of the Association of Scientific Workers was held in London during November 23–24 and attended by delegates from all parts of Great Britain. The conference was addressed by Prof. J. A. Scott Watson, chief of the advisory service of the Ministry of Agriculture, on the technical advisory services in agriculture. There was a discussion on the future of British agriculture and the part that agricultural scientists could play in the research and advisory services. Dissatisfaction with the conditions of service was expressed by many members, and it was agreed that the efficiency of the food production programme might be seriously impaired unless far more adequate provision was made for science and scientific workers. The present critical labour situation in the industry was discussed in detail. A delegate from the National Union of Agricultural Workers stated that the shortage of labour has been greatly exaggerated, and that the introduction of foreign labour is in no way a permanent solution of this difficulty. Mechanization, improved wages and living conditions and an apprenticeship scheme would be of more value.

Many resolutions covering a wide field were discussed, including the need for improved co-ordination between universities and existing institutes for planning more fundamental agricultural research, and the provision of conditions to attract first-class men of science to this work. It was urged that provision should be made on the agricultural research planning boards for representation of the views of the ordinary scientific worker, and that agricultural scientists in general should be assimilated to the White Paper scales as appropriate to their age and service irrespective of their previous salaries. There was considerable discussion on the National Agricultural Advisory Service.

Naming the Constellations

Henry I. Christ has an interesting article with this title in *Sky and Telescope* of October, which describes a number of proposed names for the constellations which 'fell by the wayside'. Even those suggested to flatter or honour monarchs, such as Frederick's Glory, Charles' Oak, did not survive for very long, though Sobieski's Shield, in honour of the Polish hero who fought the Turks, has been retained. How many people realize the length of the list of forgotten constellations? These include such animals as a cat, a flamingo, a turtle, a reindeer, a night owl and a thrush, and even objects like a printing office, an electric machine, a balloon, a solarium, a sceptre, and a quadrant, some of which were retained for a time, while others never gained acceptance. Wholesale recharting of the sky has not been a success, and perhaps it is just as well that the artificially fostered systems did not last.

Commonwealth of Australia Council for Scientific and Industrial Research

The annual report of the Council for Scientific and Industrial Research, Commonwealth of Australia, has now been supplemented by a more concise and popular illustrated account (Melbourne: Gov. Printer). Written by Mr. G. Lightfoot, consultant, and former secretary to the Council, with a foreword by Mr. J. J. Dedman, the Minister in Charge, it gives a lucid account of the establishment and development of the Council and of the work carried out during 1945 by the various divisions, illustrating particularly the way in which scientific research can assist the further utilization of Australian resources and the development of its industries. The Council and the author are to be congratulated on the high standard of production and exposition in this brochure, which is admirably designed for the educational purposes it is intended to serve.

Meldola Medal

The award of the Meldola Medal, which is the gift of the Society of Maccabæans, has normally been made annually, but has been suspended since 1941. The award is to be resumed for 1946, and the Society of Maccabæans will accordingly present it to the chemist who, being a British subject and less than thirty years of age on December 31, 1946, shows the most promise, as indicated by his or her published chemical work. Recommendations and applications, to be addressed to the President, Royal Institute of Chemistry, 30 Russell Square, London, W.C.1, the envelope being marked "Meldola Medal", must be received before December 31, 1946.

Catalogue of Historical Scientific Books

Messrs. Davis and Orioli's latest Catalogue, No. 125, Classics of Science and Medicine, is a lavishly illustrated production containing 444 items. The field covered includes physics, chemistry, astronomy, mathematics, biology, medicine and surgery. Many outstanding works in all these branches of knowledge are offered for sale. Among the authors represented, often by several of their works, in first or early editions, are the following,

selected more or less at random: Robert Boyle, Roger Bacon, Descartes, Galileo, William Gilbert, William Harvey, Hippocrates, Robert Hooke, James Hutton, Christian Huygens, Johannes de Ketham, Lavoisier, Sir Isaac Newton, Ambroise Paré, Pasteur, Scheele, and Vesalius. The prices asked, and presumably obtainable, are in many cases high; and are an indication of the marked trend in recent years for early scientific and medical works to appreciate in value. An interesting sidelight as to how the scarcity, as opposed to the absolute scientific importance, of a book may affect values is afforded by a comparison of the prices asked for James Hutton's "Theory of the Earth" (£175) on one hand, and Newton's "Principia" (1st edition, 2nd issue, £130) on the other. It has long been realized that copies of the former are extremely difficult to find, and also that it was an epoch-making work; yet it can scarcely be claimed that it ranks in importance with Newton's *magnum opus*.

Colonial Service Appointments

THE following appointments in the Colonial Service have been announced: A. L. Barcroft, to be agricultural officer, Malaya; P. A. Donovan, to be agricultural officer, Sierra Leone and Gambia; A. Hyslop, to be agricultural survey officer, Gold Coast; N. F. Robertson, to be plant pathologist, West Africa Cocoa Research, Gold Coast; P. F. Burgess, to be assistant conservator of forests, Malaya; W. E. S. Mutch, to be assistant conservator of forests, Nigeria; J. C. Wilson, to be assistant conservator of forests, Gold Coast; Major D. J. Gear, to be geologist, Uganda; Flt.-Lieut. E. G. Davey, to be assistant director, Observatory, Mauritius; Lieut. C. G. Dixon, to be senior geologist, British Guiana; R. Mather, to be meteorological officer, Malaya; T. Bell, agricultural superintendent, British Guiana, to be senior agricultural officer, Palestine; E. J. Shrubshall, senior assistant conservator of forests, Malaya, to be conservator of forests, Malaya; G. W. Somerville, senior assistant conservator of forests, Malaya, to be conservator of forests, Malaya.

Announcements

DR. JULIAN HUXLEY, executive secretary of the Preparatory Commission of the United Nations Educational, Scientific and Cultural Organisation, has been appointed director-general of the Organisation.

MR. J. M. COOK, sometime lecturer in classical archæology in the University of Edinburgh, has been appointed director of the British School of Archæology in Athens.

DR. ALEXANDER MULLER, of the Davy Faraday Research Laboratory of the Royal Institution, has been appointed deputy director of the Laboratory.

THE Pest Infestation Laboratory of the Department of Scientific and Industrial Research, originally set up at Slough, Bucks, in 1940, is to be extended. Mr. G. V. B. Herford, at present officer-in-charge, has been appointed director of the Laboratory.

THE Olaf Bloch Memorial Award was founded by the Institute of British Photographers and the Royal Photographic Society jointly in 1946 as a tribute to the memory of Olaf Bloch. The award, consisting of books to the value of about £10, will be given for an essay, the subject of which for 1947 is "The Effect of the Introduction of Panchromatic Emulsions on the Applications of Photography". Particulars can be obtained from the Secretary, Institute of British Photographers, 49 Gordon Square, London, W.C.1; the closing date for the competition is June 1, 1947.

THE Institution of Civil Engineers has arranged three Christmas lantern lectures for boys on "Railways: How They Are Built and How They Run", to be delivered by Mr. Cecil J. Allen (December 30), Mr. L. G. B. Rock (January 3) and Mr. O. S. Nock (January 6). Tickets are issued for each lecture, and can be obtained free of charge from the Secretary, Institution of Civil Engineers, Great George Street, Westminster, S.W.1. The lectures are primarily intended for boys between thirteen and seventeen years of age.

A COURSE of twelve lectures on "Recent Advances in Dairy Technology" is to be given at the Central Laboratories, Express Dairy Co. Ltd., under the auspices of Chelsea Polytechnic early in the New Year. The lectures will be given on Tuesdays at 6.30 p.m., beginning on January 14, and are intended to serve the interests not only of persons engaged in the control of milk in its preparation for the consumer but also of medical officers of health, public analysts, food chemists and others concerned with milk as a foodstuff and with public health. The fee for the course is £1; particulars are available from the Chelsea Polytechnic. An inaugural address, open to the public, will be given by Dr. N. C. Wright, director of the Hannah Dairy Research Institute, on January 7.

A SHORT course of about twelve lecture-demonstrations on television practice, commencing Thursday, January 16, at 7–9 p.m., have been arranged at the South East London Technical Institute, Lewisham Way, London, S.E.4. The fee for the course is £1. Particulars can be obtained from the head of the Electrical Engineering Department of the Institute.

THREE graduate memberships of the Royal Institution are to be awarded in 1947. Graduates of either sex, of any university of the British Empire, who have graduated during 1946 with first- or second-class honours in any scientific subject, are eligible. Forms of application can be obtained from the General Secretary, Royal Institution, 21 Albemarle Street, London, W.1, to whom they must be returned by January 15.

THE Council of the Institution of Metallurgists has made arrangements for the operation of an appointments register, commencing in January 1947, the purpose of which is to put in touch members of the Institution who are seeking posts and employers having vacancies on their metallurgical staffs. Inquiries should be addressed to the Registrar, Appointments Register, Institution of Metallurgists, 4 Grosvenor Gardens, London, S.W.1.

IN the note entitled "Documentation in Switzerland" in *Nature* of November 23, p. 742, it was stated incorrectly that the publication under notice was by T. van Schelven and published by the Kosmos Publishing Co. of Amsterdam. The pamphlet is issued by the Schweizerische Vereinigung für Dokumentation from the library of the Technical High-School, Zurich.

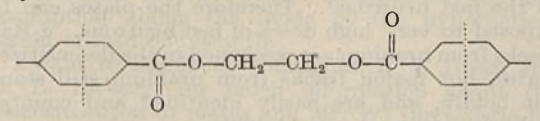
LETTERS TO THE EDITORS

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

Structure of Terylene

THE recent joint announcement by the Calico Printers' Association and Imperial Chemical Industries, Ltd., of the discovery of a new fibre-forming polymer permits the publication of the following short account of an X-ray investigation carried out on this material in the summer of 1944. The fibres, now known to be terylene, were prepared by Dr. D. V. N. Hardy at the Chemical Research Laboratory, Department of Scientific and Industrial Research, Teddington, and they had been submitted for other examination.

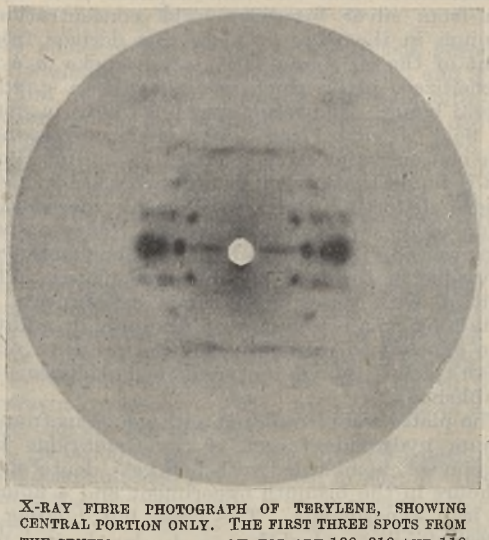
Polyethylene terephthalate (terylene) gives a well-oriented X-ray fibre diagram, and some forty spots have been indexed unequivocally on the basis of a one-molecule triclinic unit cell. The dimensions of this unit cell, taking [*c*] as the fibre axis, are [*a*] = $5{\cdot}5_4$ A.; [*b*] = $4{\cdot}1_4$ A.; [*c*] = $10{\cdot}8_6$ A.; $\alpha = 107°_{5'}$; $\beta = 112°_{24'}$; $\gamma = 92°_{23'}$. The repeating unit of terylene:



may possess a centre of symmetry, and the space group is probably $P\bar{1}$. The theoretical density required by the above unit cell is 1·47 gm./c.c., but the experimental determination is rendered somewhat uncertain by swelling, etc. Average values of 1·41 gm./c.c. have, however, been obtained by flotation in sodium iodide solutions.

Taking the bond-lengths C–C = 1·54 A., C–O = 1·42 A., C(ring)–C(aliphatic) = 1·48 A., and standard angles, the calculated period along the fibre axis comes to 10·9 A., in agreement with the value [*c*] = $10{\cdot}8_6$ A. given by the X-ray photographs.

In the usual way, X-ray fibre photographs reveal increasing disorientation simply by a drawing-out of the spots into arcs, but terylene is peculiar in that poorly oriented preparations give photographs like those produced by a single crystal rotating about an axis inclined at a small angle to a principal axis; the spots are displaced to varying extents out of the true layer-lines, and in particular the intense $1\bar{1}0$ reflexion is seen as two overlapping spots, one just above and the other just below the equator. This means that in the drawing process it is somehow more difficult to pull the $(1\bar{1}0)$ planes into parallelism with the fibre axis. The spacing of these planes is 3·38 A., and their intensity is far the strongest in the photograph, which suggests that the terylene chains are approximately flat and lie in the $(1\bar{1}0)$ planes. Presumably then, on drawing out a fibre, the chains or groups of chains are first pulled straight by slipping parallel to the $(1\bar{1}0)$ planes, and afterwards, with more difficulty, these planes themselves are pulled into parallelism.



X-RAY FIBRE PHOTOGRAPH OF TERYLENE, SHOWING CENTRAL PORTION ONLY. THE FIRST THREE SPOTS FROM THE CENTRE ALONG THE EQUATOR ARE 100, 010 AND $1\bar{1}0$

A three-dimensional model, in which the oxygen atoms in neighbouring chains are found to approach to approximately 3·1 A., has been constructed in accordance with the above scheme, and the X-ray intensities calculated from it are in good agreement with those observed. The full details will be published elsewhere.

W. T. ASTBURY
C. J. BROWN

Department of Biomolecular Structure
and Textile Physics Laboratory,
University of Leeds.
Nov. 18.

Determination of the Upper Limits of the Fission Cross-sections of Lead and Bismuth for Li-D Neutrons by a Chemical Method

THEORETICALLY, fission of elements of atomic number 83 and less is not excluded. The fission thresholds for the compound nuclei formed in neutron capture by lead and bismuth have been estimated as 9·3 MeV. for Bi^{210}, 10·0 for Pb^{207}, 10·4 for Pb^{208} and 10·7 for Pb^{209} [1]. If the neutron-binding energy is 5·4 MeV. for initial nuclei with an even, and 6·4 MeV. with an odd, number of neutrons, 3·9, 4·6, 4·0 and 5·3 MeV. have to be supplied as kinetic neutron energy to Bi^{209}, Pb^{206}, Pb^{207} and Pb^{208} to reach the presumed fission thresholds. We have searched for the fission of lead and bismuth with fast neutrons from the Li-D reaction by looking for any radio-iodine formed. In chemical methods for the measurement of fission-rates, very much larger amounts of material can be used than in fission chambers. On the other hand, chemical methods in a hypothetical process are based on the admittedly uncertain assumption that the element selected would appear as a fission product. We have chosen iodine as it is in the middle of one of the groups of fission products from uranium, and several of its isotopes are produced abundantly with this element. The ease of extraction of iodine was the reason why Libby[2] used it in an experiment to set a limit to the spontaneous fission-rate in uranium.

In separate runs, 7 kgm. lead oxide and 4·5 kgm. bismuth oxide were irradiated for 6½ hours in a tin fitting closely the lithium hydroxide target tube of the Cambridge High Tension set. The current of 900 keV. deuterons was 50 μ amp. After irradiation, the material was dissolved with stirring in nitric acid under a toluene layer containing 500 (lead run) or

700 (bismuth run) mgm. iodine. The aqueous layer was removed in a separating funnel, the toluene washed with dilute acid and water, and iodine extracted from the toluene with sulphur dioxide solution. To the iodide solution so produced excess copper sulphate was added, the precipitated copper iodide filtered, washed with sulphur dioxide solution, water and acetone and tested with a mica window Geiger–Müller counter. Uranium (that is, U^{238}) was used as a monitor. Uranium nitrate ($UO_2(NO_3)_2 . 6H_2O$)—34 gm. in the lead run, 20 gm. in the bismuth run—was embedded in the bulk material in a tube at a representative distance, and after irradiation worked up in the standard way with 500 or 200 mgm. iodine carrier. Naturally, here the yield of copper iodide was higher, as there was less opportunity for chemical or handling losses.

The ratio of the cross-sections is given by

$$\frac{\sigma}{\sigma_{U^{238}}} = \frac{A}{A_U}\,\frac{W_U}{W}\,\frac{M}{M_U}\,\frac{P}{P_U}\,\frac{Y_U}{Y}\,f,$$

where A are the measured activities, W the weights (of the elements) irradiated, M the atomic weights, P the weights of the iodine carrier used, Y the weights of the copper iodide recovered, and f an estimated factor to account for the difference in the self-absorptions. After deduction of the background (26 counts/min.), the copper iodide (41·5 mgm.) from lead gave 3 ± 1, and the copper iodide (228 mgm.) from uranium 2,190 counts/min. 90 min. after irradiation. In the bismuth run, the figures were $-1{\cdot}5 \pm 1{\cdot}5$ (21 mgm. copper iodide) and 1,605 (206 mgm.) 75 min. after irradiation. If we accept as an upper limit of the activity of the sample the difference against the background plus three times the probable error, we get

$$\frac{\sigma_{Pb}}{\sigma_{U^{238}}} < \frac{6 \times (34 \times 0{\cdot}474) \times 207 \times 0{\cdot}5 \times 0{\cdot}228}{2190 \times (7000 \times 0{\cdot}928) \times 238 \times 0{\cdot}5 \times 0{\cdot}0415}\ 0{\cdot}40 < 1{\cdot}3 \times 10^{-5}$$

$$\frac{\sigma_{Bi}}{\sigma_{U^{238}}} < \frac{3 \times (20 \times 0{\cdot}474) \times 209 \times 0{\cdot}7 \times 0{\cdot}206}{1605 \times (4500 \times 0{\cdot}897) \times 238 \times 0{\cdot}2 \times 0{\cdot}021}\ 0{\cdot}38 < 5{\cdot}0 \times 10^{-5}.$$

These figures refer to the whole Li-D spectrum, and in the case of lead to the natural isotopic mixture. The cross-sections referring to individual isotopes and to neutrons above the calculated thresholds are more significant. The abundances of the main isotopes of lead are 0·236, 0·226 and 0·523, and the abundances of the 'effective' neutrons can be derived from the data by Richards[3] as 0·63, 0·67 and 0·58 for Pb^{206}, Pb^{207}, Pb^{208}, and 0·68 for bismuth. Practically all Li-D neutrons are effective in the fission of U^{238}. Then,

$$\frac{\sigma_{Pb^{206}}}{\sigma_{U^{238}}} < 9 \times 10^{-5} \qquad \frac{\sigma_{Pb^{207}}}{\sigma_{U^{238}}} < 9 \times 10^{-5}$$

$$\frac{\sigma_{Pb^{208}}}{\sigma_{U^{238}}} < 4 \times 10^{-5} \qquad \frac{\sigma_{Bi}}{\sigma_{U^{238}}} < 7 \times 10^{-5}$$

In view of the many uncertainties, including iodine yields in fission, energy losses of the neutrons through scattering in the material and the surroundings, and dependence of cross-sections on energy above the thresholds, the figures must be considered as very approximate only.

We want to express our thanks to Prof. N. Feather for helpful discussions, and to Mr. W. Birtwhistle for running the Cambridge High Tension set. This investigation was carried out between January and April 1945 in the Cavendish Laboratory, Cambridge, for the Directorate of Tube Alloys.

E. Broda
P. K. Wright
Department of Natural Philosophy,
University, Edinburgh.
Nov. 15.

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Determination of the Upper Limits of the Fission Cross-sections of Lead and Bismuth for Li-D Neutrons by a Track Count Method

Following the unsuccessful search for fission of lead and bismuth by a chemical method[1], an attempt was made using track counts in irradiated 'loaded' plates. It is possible through desensitization (bathing for 5 min. in 1 per cent chromic acid, rinsing with water and drying) before irradiation to suppress fogging by γ-rays and the proton recoil tracks due to the fast neutrons[2]. Therefore the plates can be exposed to very high doses of fast neutrons. α-Ray tracks from uranium are weakened in the desensitized plates, but fission tracks from uranium still stand out boldly, and are easily identified and counted under a microscope (× 1,500).

The plates used were Ilford Concentrated Half-Tone Plates of emulsion thickness 20 μ [3]. The plates were loaded by a 30 min. bath in bismuth lactate solution in 10 per cent acetic acid, or alternatively, in lead acetate solution in 10 per cent acetic acid, quickly rinsed with water and dried. Monitor plates were made by impregnation in the same way with uranyl acetate in 10 per cent acetic acid. The area concentrations of bismuth (0·082 mgm./cm.^{2} = $3{\cdot}9 \times 10^{-7}$ gm.-atom/cm.^{2}) and lead (0·296 mgm./cm.^{2} = $14{\cdot}3 \times 10^{-7}$ gm.-atom/cm.^{2}) in the emulsions were estimated gravimetrically by converting the bismuth and lead salts from a known area into bismuth oxide and lead sulphate after separation from silver bromide. The concentration of uranium in the monitor plate was derived from a count of the (U^{234} and U^{238}) α-ray tracks in a (not desensitized) plate which was allowed to stand for several hours. The result was 6·0 tracks in 8·4 hr. per field of view ($7{\cdot}85 \times 10^{-5}$ cm.^{2}) corresponding to a concentration of $4{\cdot}4 \times 10^{-7}$ gm.-atom U/cm.^{2}.

It is found that strong loading with heavy metals, besides distorting the tracks, has a desensitizing action of its own towards α-rays. Hence a special check was applied to find whether fission tracks would be visible in the lead and bismuth plates. Plates identical with those in the main experiments, but containing small amounts of uranium in addition, were exposed to neutrons, and the presence of the fission tracks—though in a weakened condition—was established.

The plates were irradiated with neutrons from the lithium hydroxide target of the Cambridge High Tension set, bombarded with 900 keV. deuterons for $2\frac{3}{4}$ hours in the bismuth experiment and 4 hours in the lead experiments. The brass box holding the plates actually touched the target tube. In each plate

1,000 fields of view were searched for fission tracks, and none was found. The number of fission tracks in the monitor plates were 6·8 and 6·9 per field of view. To have an ample safety margin, it will be assumed merely that there is, then, less than one fission track per 300 fields of view in each case. The cross-sections σ, in terms of $\sigma_{U^{238}}$, are given by

$$\frac{\sigma}{\sigma_{U^{238}}} < \frac{c_U}{c}\,\frac{N}{N_U}$$

where c are the concentrations, and N the track counts. Hence,

$$\frac{\sigma_{Pb}}{\sigma_{U^{238}}} < \frac{4{\cdot}4 \times 10^{-7}}{14{\cdot}3 \times 10^{-7}} \times \frac{0{\cdot}0033}{6{\cdot}9} < 1{\cdot}47 \times 10^{-4}$$

$$\frac{\sigma_{Bi}}{\sigma_{U^{238}}} < \frac{4{\cdot}4 \times 10^{-7}}{3{\cdot}9 \times 10^{-7}} \times \frac{0{\cdot}0033}{6{\cdot}8} < 5{\cdot}5 \times 10^{-4}.$$

Referring again to individual isotopes and 'effective' neutrons[1], we get

$$\frac{\sigma_{Pb^{206}}}{\sigma_{U^{238}}} < 1 \times 10^{-3} \qquad \frac{\sigma_{Pb^{207}}}{\sigma_{U^{238}}} < 1 \times 10^{-3}$$

$$\frac{\sigma_{Pb^{208}}}{\sigma_{U^{238}}} < 5 \times 10^{-4} \qquad \frac{\sigma_{Bi}}{\sigma_{U^{238}}} < 8 \times 10^{-4}$$

These limits are, of course, independent of any assumption about the mode of the hypothetical fission of lead or bismuth.

I want to thank my colleagues, L. L. Green and D. L. Livesey, for much information about the desensitization of plates and Mr. W. Birtwhistle for running the Cambridge High Tension set. This investigation was carried out between January and June 1946 in the Cavendish Laboratory, Cambridge, for the Department of Atomic Energy.

E. Broda

Department of Natural Philosophy,
The University,
Edinburgh.
Nov. 15.

[1] See preceding communication.
[2] Cf. Green and Livesey, *Nature*, 158, 272 (1946).
[3] Cf. Powell, Occhialini, Livesey and Chilton, *J. Sci. Instr.*, 23, 102 (1946).

Use of Lead Sulphide Cells in Infra-red Spectroscopy

The photoconductive properties of lead sulphide when irradiated by wave-lengths between 1 and 3·5 μ were first utilized as a means of detecting infra-red radiation during the War by the Germans. In the later stages, lead sulphide detector cells were developed by the Admiralty[1] and in the United States[2], for within their range of operation they are far superior to any other detector in speed and sensitivity. The purpose of the present note is to indicate their possibilities as a tool in infra-red spectroscopy, and to describe some of our results in applying them to the attainment of high resolving power in the near infra-red region of the spectrum. The cells used by us were made at the Admiralty Research Laboratory by the evaporation process, and were cooled to a temperature of about — 78° C. by a mixture of solid carbon dioxide and acetone.

The variation of sensitivity with wave-length of a typical lead sulphide cell is shown in Fig. 1. It will be noted that the sensitivity is by no means uniform ; it rises to a maximum at 2·6 μ and then falls steeply

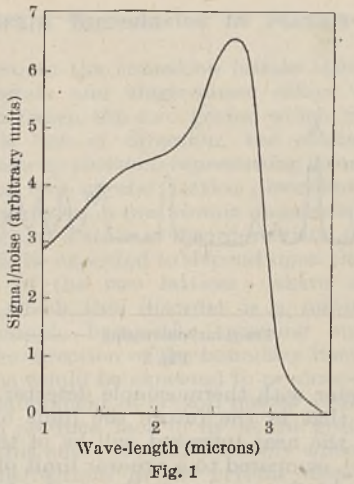
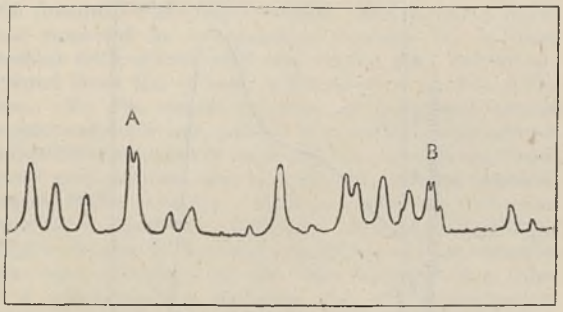


Fig. 1

until at about 3·4 μ it becomes inferior to the thermocouple. We have found that appreciable sensitivity persists until about 3·6 μ. The fact that the sensitivity of the lead sulphide cell greatly exceeds that of the best thermocouple only below 3 μ means that its use in the examination of fundamental frequencies is virtually restricted to NH, OH and FH frequencies. However, the first overtone of practically any fundamental stretching frequency involving a hydrogen atom will occur at wave-lengths shorter than 3 μ and so will be accessible to the new detector. In other words, any molecule containing a hydrogen atom should have at least one overtone frequency which can now be examined under higher resolving power than has ever been possible hitherto.

It is not yet possible to state precisely the exact increase in resolving power available, since we find that lead sulphide cells vary considerably in performance ; and it is by no means certain either that the maximum sensitivity has been reached, or that the best design for spectroscopic work has been produced. However, there is no doubt from our experiments that the signal/noise ratio for the lead sulphide cell at its point of maximum sensitivity is of the order of 100 times that of the Hilger–Schwarz thermocouple. This would imply that slit-widths could be reduced by a factor of 10 in going from thermocouple to lead sulphide detector, with a corresponding increase in resolving power. In practice, such an increase may not be attainable because of purely optical considerations, for example, aberrations or diffraction limits. Thus in our experiments with a grating spectrometer we find that reduction by a factor of 4 brings us to the diffraction limit. This is a point which we wish to emphasize : namely, if the full possibilities of the lead sulphide cell are to be realized, much more attention will have to be paid to the optics of infra-red spectrometers than in the past, when the resolving power was nearly always limited by the sensitivity of the detector.

An example of the increased resolving power which we have already achieved is given in Fig. 2, which shows a portion of the H_2O band at 3970 cm.$^{-1}$ obtained with a non-echelette grating of 14,400 lines/inch. The separation of the lines in the doublet marked A is 0·25 cm.$^{-1}$ and of those in the doublet B is 0·14 cm.$^{-1}$. The slit width employed was 0·08 cm.$^{-1}$. The closest pair of lines previously resolved in this band had a separation of 0·6 cm.$^{-1}$, namely, the pair at 3566·2 and 3566·8 cm.$^{-1}$ resolved by Nielsen[3] using a grating



Frequency increasing ———

Fig. 2

spectrometer with thermocouple detector. It seems probable that in the future the limit of resolving power in the near infra-red will be of the order of 0·05 cm.$^{-1}$, compared to a pre-war limit of 0·5 cm.$^{-1}$.

We would also emphasize the great advantages to be derived from the exceptional speed of response of the lead sulphide detector, which has a time constant of considerably less than 0·001 sec. compared to the Schwarz thermocouple of about 0·1 sec. and the thermistor bolometer of about 0·01 sec. Quite apart from the increased speed with which spectra can be plotted, this short time-constant allows one to chop the radiation at a high frequency (we actually used 800 c./sec.) and employ a tuned detector system which entirely eliminates drift. Furthermore, the use of a lead sulphide cell in connexion with our cathode ray presentation of spectra[4] will allow much higher scanning speeds than can be achieved with a bolometer. This means that a more truly instantaneous picture of the spectrum can be obtained, or alternatively a wider range of the spectrum can be viewed continuously, than with a bolometer.

A full description of these results will be published shortly elsewhere.

We wish to acknowledge our indebtedness to the Admiralty for the loan of the cells used, and to the Telecommunications Research Establishment at Malvern for the loan of the amplifier equipment.

G. B. B. M. Sutherland
D. E. Blackwell
P. B. Fellgett

Laboratory of Colloid Science,
Cambridge.
Oct. 31.

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Angular Momentum of the Solar System

One of the main difficulties to be met by any theory about the origin of the solar system is the difficulty of accounting for the present distribution of its angular momentum.

This difficulty can be stated in the following way. If the material of the planets has originated from the sun, it is difficult to understand why the average angular momentum per unit mass of the planetary material should be about 50,000 times larger than the average angular momentum per unit mass of the solar material. If, however, the planetary material was at the beginning present in a nebula around the sun, the density of this nebula was too small for a condensation into solid bodies under the sole influence of the gravitational forces (Roche). If, finally, the condition from which the evolution started was such that the material of the sun and the planets together was smoothed out in a nebula, the total angular momentum of the system was far larger than at present, in contradiction with the law of the conservation of angular momentum.

The apparent failure of the theories of Kant and Laplace to explain this point has led to several 'catastrophic' theories being put forward. Von Weizsäcker[1] gives in his recent theory, which is along the lines originally proposed by Kant and Laplace, an explanation which is, however, not completely convincing.

It seems, however, that it may well be possible to account for the present distribution of the angular momentum, without introducing interactions with foreign bodies, if we take into account that the condensation into planets will probably not take place under the influence of the gravitation alone, but will be a consequence of a process of condensation similar to that occurring in a supersaturated vapour, or to the process of the formation of smoke particles in interstellar space, as has been remarked already by Lindblad[2] and Jeffreys[3].

We may start thus from a situation where the sun is surrounded by a rotating nebula possessing an angular momentum which is about equal to the total angular momentum of the planetary system at present. The fact that the density in this nebula will be too low to allow condensation by gravitational action no longer prevents the actual condensation, since this condensation can proceed in the way mentioned above.

D. ter Haar

Institute for Theoretical Physics,
University of Copenhagen,
Denmark.
Nov. 4.

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Physical Basis of a New Theory of Absorption of Ultrasonics in Liquids

The relaxation theory of Kneser[1], the diffusion theory of Lucas[2], and other theories[3] have not satisfactorily explained the excessive absorption of ultrasonics in liquids, unaccompanied by any sensible dispersion. In the following we offer a possible mechanism for the phenomenon.

The relevant difference in the structure of gases and liquids is that in the former the rupturing tendency indicated by kT is much more than the cohesive tendency of intermolecular attraction forces, whereas in liquids the reverse is the case. In gases we picture the molecules as free except at collisions, on which occasion they rearrange their energies in different degrees of freedom. But the distances to be reached in collisions in gases are already nearly reached in liquids at all times, and so the conditions arising at collisions in gases lose their force in explaining the characteristic phenomena in liquids, for these conditions were present all the time. The existence of this fundamental difference becomes evident on examining the opposite temperature variation of compressibility and viscosity in gases and in liquids. In a liquid and in the ordinary state, the electron atmospheres of the molecules are affecting each other at the close

intermolecular distances existant, due to their property of polarizability. In fact, London's dispersion forces[4] are due to this mutual polarization of electron atmospheres. Our theory of absorption of ultrasonics is a further use of this mutual interaction of electron atmospheres.

We postulate that under compression brought about by ultrasonic waves, the electron atmospheres are perturbed still further, and interatomic vibrations are started. The validity of this assumption and the actual mode of starting vibrational motions have been reviewed by Oldenbergh and Frost[5]. On the approach of a molecule to a second molecule, the equilibrium internuclear distances of the atoms in the molecules change, due to the mutual distortion of the electron atmospheres. As the atoms move to occupy their new positions they overshoot the mark and vibrations result, absorbing energy. This vibrational energy is inelastic and is frittered away in the form of heat and other degrees of freedom, and constitutes a loss of ultrasonic energy.

The smaller the $h\nu$ of a particular vibration in relation to kT, the greater will be its probability of excitation. But it is to be noted that whereas, on the relaxation theory, a quantum greater than kT may not be sensibly excited at all, it has greater probability of excitation on the mechanism postulated[5].

The following phenomena are readily explained on this theory. (1) Good scatterers of light are good absorbers of sound. Richardson[6] first noted this fact. The scattering of light depends upon the square of the polarizability; this follows from the fact that the mutual interaction of electron atmospheres depends upon polarizability. (2) Classical absorption of mercury, for there are no interatomic vibrations to be excited.

Other points cleared up by the new mechanism are: (*a*) The greater the compressibility, the greater the absorption. The relative change of intermolecular distance and hence perturbation of electron atmospheres will increase with compressibility. This consideration still further increases the correspondence between absorption of sound and light scattering. Now, in general, polarizability and compressibility, as follows from London's theory of dispersion forces, vary in the opposite direction, but when they are both great, sound absorption is excessive. For example, carbon disulphide shows an absorption a thousand times the classical value. (*b*) The mechanism explains the effect of temperature and pressure on absorption, its variation with frequency and the fact that, in general, liquid mixtures show greater absorption than is shown by the components.

Again, the apparently unconnected phenomena of splitting up of heavy molecules by ultrasonics and faint emission of light by liquids carrying ultrasonics seem to be explained by the new mechanism. The details of the theory will be published elsewhere.

R. Parshad

Physical Laboratory,
Council of Scientific and Industrial Research,
University Buildings, Delhi.
Oct. 29.

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Grain Boundaries in Metals

According to the transition lattice theory, since in pure metals and single-phase alloys the only difference between the two grains which meet at a boundary is one of direction, the atoms at the boundary take up positions representing a compromise between the two crystal lattice directions. There thus exists a region, a few atomic diameters in thickness, over which a state of disorder exists, the extent of which will be expected to depend upon the relative orientation of the two lattices; there will exist angles for which this disorder is a minimum, an obvious example being the twinning angle. In addition, the direction of the boundary itself relative to the grains would be expected to produce an effect. Lateral misalignment of crystal planes would also be expected to produce 'lack of fit' at the grain boundaries, but this effect is most probably smoothed out by the imperfections in the crystal structure. It would be expected, therefore, that any phenomenon depending upon the degree of disorder existing at the boundary would vary in magnitude according to the relative orientations of the grains meeting at the boundary, and with position in the boundary between two given crystal grains if the boundary changed in direction. It is reasonable to suppose that where precipitation of a second phase occurs from the supersaturated solid solution, it occurs more readily in those regions where disorder is greatest, and it would, therefore, be expected that grain boundary precipitation would vary in this manner.

Fig. 1 shows a copper–beryllium alloy in which precipitation has occurred at the boundaries. Twinning has occurred in this specimen, and in certain cases the abrupt change in relative orientation of two grains caused thereby produces an equally abrupt change in the precipitation. Furthermore, this change is reversed and repeated where there are a number of twins. Fig. 2 shows an aluminium–5 per cent magnesium alloy in which the boundaries are revealed by the precipitation of discrete particles of the β-phase. The degree of precipitation is very different for different boundaries.

In these two cases the change of precipitation may be due to the change in relative direction of the crystals or the change in direction of the boundary, or to both together. That the direction of the boundary is significant is indicated by Fig. 3, which shows an isolated grain in a copper–beryllium alloy completely surrounded by another grain. There are marked differences in the degree of precipitation around the boundary, yet the relative orientation of the grains is not changed. While the fact that the portions of the boundary showing minimum precipitation are substantially parallel would appear to be in strong support of this explanation, too much significance may not be attached to this as the direction of the boundary within the metal is not known. It is possible, too, that the surrounding material is not, in fact, a single crystal but is composed of a number of grains the orientations of which are so near together that the boundaries are not indicated by precipitation. If this were so, the above argument would still hold.

Another phenomenon associated with the degree of disorder at the boundary is that of the formation of boundary grooves on polished metal surfaces at elevated temperatures[1]. It has been observed that the grain boundary grooves which develop on the surface of electrolytically polished high-purity silver

(1) Copper–beryllium alloy, electrolytically polished, chemically etched. × 1,000
(2) Aluminium–magnesium alloy, electrolytically polished, chemically etched. × 500
(3) Copper–beryllium alloy, electrolytically polished, chemically etched. × 750
(4) Silver, electrolytically polished, thermally etched in nitrogen. × 200
(5) Silver (same field as 4 after subsequent heating in air). × 200

show similar variations to those shown by the precipitation in Figs. 1, 2 and 3. Fig. 4 shows the appearance of a specimen of silver after alternate heating in nitrogen and air at 920° C., the last heating being in nitrogen. There is one example of a grain boundary groove which changes its appearance with change of direction, and three cases of grooves which terminate abruptly. Fig. 5, of the same surface after a subsequent heating in air, reveals the presence of twins, showing that abrupt termination of the boundary groove is due to the change in orientation produced by twinning.

In the case of thermally etched silver, since the etching takes place on a prepared surface, the orientation of the boundary relative to the free surface would be expected to have an effect. This might contribute to the change in nature of the boundary groove where it changes direction, but not to the abrupt change where twinning occurs. The variations in precipitation are, of course, not subject to the effect of the surface, since precipitation occurs in the body of the material before the surface is prepared.

P. J. E. Forsyth R. King
G. J. Metcalfe B. Chalmers
Royal Aircraft Establishment,
Farnborough, Hants. Oct. 25.

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Fungistatic Activity of Ethylenic and Acetylenic Compounds

In a recent discussion of the lachrymatory activity of some ethylenic compounds, Dixon and Needham[1] have suggested that lachrymatory properties are conferred by certain substituent groups (ketone, aldehyde, ester, nitro-, etc.) which polarize the adjacent olefinic linkages, rendering them reactive towards nucleophilic reagents.

We have studied the fungistatic activity of a considerable number of ethylenic and acetylenic compounds and had developed a similar theory to account for fungistatic activity. In view of Dixon and Needham's results, and observations we have made on bacteriostatic activity, we now consider that it may be more correct to suppose that substituent groups which tend to attract electrons confer general toxicity on living cells, the specific type of toxicity being conditioned by other factors.

The lack of parallelism between fungistatic activity and physiological effects on man (see examples in accompanying table) affords support for this view.

Compound	Fungistatic activity*	Physiological effect on man
β-Nitrostyrene	6·25	Powerful sternutator
4-Methoxy-β-nitrostyrene	7·8	Non-irritant
Cinnamic aldehyde	125·0	Pleasant aromatic odour
Ethyl acrylate	>1000·0	Unpleasant pungent odour
Ethyl propiolate	>1000·0	Highly lachrymatory

* Expressed as least concentration (μgm./ml.) inhibiting germination of *Botrytis allii* conidia.

In one respect our observations have been similar to those of Dixon and Needham. Just as they found acids to be less lachrymatory than their corresponding methyl or ethyl esters, so we have found them to be less fungistatically active. We do not consider that this is due to the carboxyl group being ineffective in producing the necessary electromeric displacement, as suggested by Dixon and Needham. On the contrary, there is considerable evidence[2–5] that the carboxyl group (though not the carboxyl ion) is a group which attracts electrons, and we consider that these observed differences in activity are more readily explained by the well-known greater permeability of living cells to esters than to acids.

Our results will shortly be published in detail elsewhere.

P. W. Brian
J. F. Grove
J. C. McGowan
Butterwick Research Laboratories,
Imperial Chemical Industries, Ltd.,
The Frythe,
Welwyn, Herts.

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Antibacterial Activity in Members of the Native Australian Flora

We are carrying out a survey of the native flora of Australia for the presence of antibacterial substances. Much of this flora is unique and may well provide new and interesting antibiotics.

Atkinson and Rainsford[1] recorded the results of a preliminary investigation of 410 species of flowering plant native to Australia, and afterwards another

group comprising about seven hundred species was examined. The tests were made against the Gram-positive type *Staph. aureus* and the Gram-negative type *Bact. typhosum*. Out of a total of approximately 1,100 species, about fifty showed antibacterial activity against *Staph. aureus*, but only four of these, namely, *Drosera Whittakeri* and three species of *Persoonia*, also affected *Bact. typhosum*. Substances active against both Gram-positive and Gram-negative bacteria are of special interest on account of their possible potential value in the chemotherapy of a wide range of infections. These four plants were therefore selected for more extensive examination.

The activity appeared in extracts of leaves and stems of the *Drosera* and in extracts of the berries of the *Persoonias*. Bulk extraction of the active parts of these plants was carried out, and attempts are being made to purify the active substance. Some characterization of the *Persoonia* substance has so far been achieved. In crude extracts, the activity was greater against *Bact. typhosum* than against *Staph. aureus*. This activity was readily destroyed by alkalinity (*p*H 9) but persisted in acid solution (*p*H 2) for several hours at least, and was not destroyed by heating at 100° C. for at least 45 minutes. Crude extracts kept at 4° C. retained their activity for at least eight months. The active substance did not appear to be volatile in steam; it was absorbed by charcoal, from which it was partly recovered by elution with ethyl alcohol. Work on further purification of this material is proceeding.

The majority of the other plants active only against *Staph. aureus* belonged to the Myrtaceæ, a family well represented among the native Australian flora. Further investigation of *Chamælaucium uncinatum*, in which activity was detected only in the flowers, and *Darwinia citriodora*, in which activity appeared in both flowers and leaves, located the antibacterial substance in the oil obtained by steam distillation of the active part of the plant. These oils have provoked our interest because they exhibited antibacterial activity against *Myco. phlei*, an acid-fast bacillus. Any material showing action against the Mycobacteria is worthy of attention; these oils are therefore undergoing fractionation with the object of isolating the active constituents.

Detailed reports of this work will appear elsewhere.

Nancy Atkinson

Institute of Medical and Veterinary Science,
Adelaide.
Sept. 23.

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Action of Thionyl Chloride on Carboxylic Acids in Presence of Pyridine

The catalytic effect of small amounts of pyridine in the reaction between thionyl chloride and carboxylic acids is well known; Carré and Libermann[1] have shown further that it is of great advantage to use equimolar quantities of acid, pyridine, and thionyl chloride, the acid chloride then being formed rapidly at lower temperatures, in high yield. This convenient method apparently has not been very widely used, and instructions for making acid chlorides generally call for the use of excess thionyl chloride and 'a few drops' of pyridine.

Finding it necessary to prepare substituted amides from the hydrogen phthalates of secondary alcohols, we have followed a process essentially the same as that of Carré and Libermann, but have prepared and tested for the intermediate acid chlorides in solution, without attempting to isolate them. This method has given very good results, and would seem to be generally applicable to the preparation of derivatives from acids which are too unstable to withstand the action of heat or excess thionyl chloride.

In general, the acid was dissolved in ten volumes of dry solvent (ether was preferred, but benzene, chloroform or carbon tetrachloride could be used) treated with one equivalent of dry pyridine, and then exactly one equivalent of purified thionyl chloride[2] was added, drop-wise with stirring. Pyridine hydrochloride separated, except when chloroform was the solvent, and the mixture was left at 15–20° for an hour. The alcohol or amine to be coupled with the acid chloride was mixed with one equivalent of pyridine, and added drop-wise with stirring; then the ester or amide was recovered and purified by the usual methods. From *cyclo*hexyl hydrogen phthalate, by the action of thionyl chloride and pyridine, followed by coupling with aniline, we obtained *cyclo*hexyl phthalanilate, m.p. 111·5°, in yields exceeding 80 per cent.

Experiments by L. H. Darling indicate that esters made by this general method may contain traces of sulphur compounds, and are unsuitable for catalytic hydrogenation.

J. P. E. Human
John A. Mills

Johnson Chemical Laboratories,
University of Adelaide.
Oct. 31.

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Measurement of the Photodynamic Effect of Cancerogenic Substances with Biological Indicators

The photodynamic effect of cancerogenic substances was examined by Mottram and Doniach[1] using *Paramecium*. They found that the cancerogenic substances had a stronger effect than the non-cancerogenic photosensitizers. We have tried to estimate the photodynamic effect of cancerogenic substances by means of a standard biological indicator, namely, the 3rd stage larvæ of *Drosophila melanogaster*, as it is known that they are suitable for the standardizing and measuring of radiation.

We used for the experiments a five years inbred white-eyed strain (white 4 ch. 1·5 Morgan unit). To 13 gm. standard *Drosophila* food we added 1 mgm. benzpyrene, methylcholanthrene or dibenzanthracene, and the imagos on this food laid eggs. The animals were in the dark. We found by fluorescence microscopy that the cancerogenic substances were in the organs and cells in a dissolved state. We radiated groups of some forty larvæ with a quartz mercury lamp (Hanau type Jubiläums Höhensonne 2·5 amp., 220 V.) from a distance of 36 cm. at 24–26° C. Their death was observed under these conditions, and the duration of the radiation was noted.

The control larvæ, which were bred on standard *Drosophila* food, died after 39 min. 51 sec. ± 4 min. 17 sec. The larvæ treated with benzpyrene died after 6 min. 30 sec. ± 1 min. 15 sec.; with methylcholanthrene after 13 min. 35 sec. ± 1 min. 57 sec.;

with dibenzanthracene after 19 min. 34 sec. ± 3 min. 35 sec.

It is evident that the benzpyrene has the strongest photodynamic effect; after this comes methylcholanthrene, and dibenzanthracene is last. Roughly speaking, methylcholanthrene has a half, dibenzanthracene a third, as strong photodynamic effect as benzpyrene. The benzpyrene-treated larvæ perished with a sixth of the ultra-violet radiation required for the controls, the methyl-cholanthrene-treated larvæ with a third, and the dibenzanthracene-treated larvæ with half as much.

G. Matoltsy
Gy. Fábián

Biological Research Institute,
Tihany.
Oct. 26.

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Action of Heparin on the Venom of *Echis carinatus*

Ahuja *et al.*[1] have presented experimental evidence to show that heparin is capable of neutralizing the blood-coagulant action of Russell's viper venom *in vitro* and of counteracting to a considerable extent the toxicity of this venom *in vivo*. Further studies were undertaken to find out if heparin exerted a similar action on the venom of the other common Indian viper, *Echis carinatus*. The venom used in the experiments was obtained through the courtesy of the director of the Haffkine Institute, Bombay. It was a well-dried sample composed of a mixture of the venom extracted from several *Echis* vipers.

Heparin was a solution in physiological saline of the sodium salt of heparin of a strength of 10 mgm. per ml., each mgm. representing 110 Toronto units approximately.

Table 1. Action on blood-coagulant activity of *Echis* venom *in vitro*

Echis venom (mgm.)	Heparin (mgm.)	Sheep blood (ml.)	Result
0·1	Nil	1·0	Clot 36 sec.
0·1	1·0	1·0	Clot 2 min. 35 sec.
0·01	Nil	1·0	Clot 42 sec.
0·01	1·0	1·0	Clot 8 min. 25 sec.
0·001	Nil	1·0	Clot 2 min. 15 sec.
0·001	1·0	1·0	Clot 90 min.
0·0001	Nil	1·0	Clot 4 min. 55 sec.
0·0001	1·0	1·0	No clot 8 hr.; clot 24 hr.
Nil	Nil	1·0	Clot 8 min.
Nil	1·0	1·0	No clot 24 hr.

It will be seen from Table 1 that (*a*) 1·0 mgm. of heparin in the presence of 0·01 mgm. of *Echis* venom can prolong the clotting time of blood from 42 sec. to 8 min. 25 sec., which is the normal clotting time of sheep blood; and (*b*) 1 mgm. of heparin is unable to prevent the coagulant action of even 0·0001 mgm. of *Echis* venom, although it can prolong the clotting time from 4 min. 55 sec. to 8 hours.

Table 2. Action on toxicity of *Echis* venom *in vivo*
Echis venom and heparin mixed, incubated at 37° C. for 30 minutes and the mixture given intravenously to rabbits

Rabbit weight (gm.)	Venom (mgm.)	No. of lethal doses injected	Heparin (mgm.)	Result
1275	0·02	2	Nil	Died 1 min.
1650	0·01	1	Nil	Died 19 min.
1875	0·01	1	Nil	Died 15 min.
1725	0·005	½	Nil	Survived
1800	0·01	1	5	Survived
1885	0·1	10	7	Survived
1480	0·2	20	15	Survived
1500	0·2	20	15	Survived
1650	0·3	30	30	Died 10 min.
1695	0·3	30	50	Died 3½ hr.

The minimum lethal dose of *Echis* venom for rabbits was found to be 0·01 mgm. This dose consistently killed the animals in 15–20 min. when given intravenously. When *Echis* venom was mixed with heparin and given intravenously, the animals did not die even though the dose of venom injected was twenty times the lethal dose. With the dose of venom increased to 30 times the lethal dose, even 50 mgm. of heparin could not save the animal.

In the light of our previous studies on the action of heparin on the venom of *V. russellii*, in which it was shown that one part by weight of heparin could effectively counteract *in vivo* the lethal action of at least an equivalent amount of Russell's viper venom, the results obtained with *Echis* venom show that: (1) comparatively a much larger quantity of heparin is required to counteract the toxic effect of *Echis* venom under experimental conditions *in vivo*; (2) weight for weight, *Echis* venom is a much more powerful blood coagulant than the venom of *V. russellii*; and (3) when the dose of *Echis* venom injected is increased beyond certain limits, namely, twenty times the minimum lethal dose, some of the animals show paralysis of the limbs and gradually increasing respiratory failure as against the usual convulsive seizures seen with smaller doses. It is possible that with higher doses, toxic fractions other than the one responsible for intravascular coagulation, for example, neurotoxic or hæmorrhagic fractions, increase from a sub-lethal to a lethal level. Heparin is obviously ineffective against these other fractions.

In view of the fact that *Echis* is a small snake which seldom gives more than one or two lethal doses in a full bite in man, and that, too, subcutaneously, these results are sufficiently encouraging to warrant the therapeutic trial of heparin in cases of *Echis* bite, particularly when specific antivenene is not available.

We are indebted to Messrs. Eli Lilly and Co. for the supply of heparin used in these experiments.

M. L. Ahuja
N. Veeraraghavan
I. G. K. Menon

Pasteur Institute of Southern India,
Coonoor.
Oct. 14.

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Action of Mustard Gas on the Bone Marrow

In their article on "Biochemical Research on Chemical Warfare Agents", Dixon and Needham[1] refer to the work of Wormall and his co-workers[2] on the distribution of mustard gas (H.) in the organs of rabbits which have been injected with a preparation of H. containing radioactive sulphur. It was found that the bone marrow contained only about one twentieth of the amount detected in the kidneys and lungs. Dixon and Needham go on to say: "It is surprising that marrow, the tissue most damaged, had the lowest H. content, while the two tissues with by far the highest H. content are practically undamaged by H. poisoning". They then develop a theory to account for these findings.

This interpretation, however, ignores the finding that mustard gas exercises drastic effects on the nucleus. It is capable of breaking chromosomes and thus interferes with mitosis or inhibits it altogether[2–4].

This effect will obviously be observed essentially in still actively dividing tissues, which will thus be expected to be particularly sensitive to the action of mustard gas. In accordance with this expectation, it has been found[5] that in the adult *Drosophila*, in which the only organ with actively dividing cells is the gonad, mustard gas produces a selective action on gametogenesis, while in developmental stages of the same flies, doses of mustard gas which affect the germ cells are usually harmful or definitely lethal to the animal as a whole, presumably because cells in many other tissues are also actively dividing.

In adult mammals the bone marrow is one of the few tissues in which cell division is actively proceeding. It is, therefore, not surprising that it is also highly sensitive to the action of mustard gas, even though it only contains comparatively small amounts of it.

C. Auerbach
J. M. Robson

Department of Pharmacology,
Guy's Hospital Medical School,
University of London,
and
Institute of Animal Genetics,
University of Edinburgh.

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Specific Serological Characters of the Mucoids of Hog Gastric Mucin

The demonstration that purified and apparently homogeneous specimens of 'A-substance' prepared from commercial hog gastric mucin possess both A and O blood-group specificity, whereas A-substance isolated from the fluid contents of human pseudomucinous ovarian cysts[1] shows no significant O activity, suggested that a closer and more detailed examination of the hog mucin 'A-substance' for homogeneity should be undertaken. The best specimens of A-substance of animal origin examined so far have been obtained from commercial preparations of hog gastric mucin or pepsin[2], each batch of which contains material from the stomachs of many hogs. In view of the differences known to exist in the serological specificity of the gastric secretions of man[3], it seems not improbable that similar serological differences exist in the mucin preparations derived from individual hog's stomachs, and an examination of the serological properties of the mucoids isolated from single stomachs was therefore undertaken.

The individual stomach linings were finely chopped and were allowed to autolyse at *p*H 3–4 and at 37° for several days in the presence of toluene. The tissue undigested after this time was removed by centrifugation, the resulting opalescent supernatant fluid was treated with three times its volume of ethanol, and the precipitate, which contained the serologically active material, was dissolved in water, dialysed and reprecipitated with alcohol. Mucoid material was obtained in this way from twenty-four stomachs, and a serological examination of the preparations revealed that fourteen possessed A specificity only, whereas those remaining showed O specific character alone. It is noteworthy that in the series examined, no preparation of mucoid possessed both A and O specificity, as did the mucoid material obtained from hog gastric mucin of commercial origin, and no specimen was without either A or O character. The occurrence in hog gastric mucin of a mucoid material which possesses a single serological character that is very similar to, if not identical with, the human blood group O factor is thus demonstrated. The mucoid possessing O-specificity alone is presumably the material recently described as inactive mucoid by Bendich, Kabat and Bezer[4] as a result of their careful studies on the A-specific component of mucoid preparations obtained from individual hog stomachs.

Up to the present time, no technique for the isolation of the blood-group substances has been described that involves more than a few simple chemical and physical methods, and it is not surprising, therefore, that the application of these techniques fails to separate the blood-group substances one from the other in a mixture of A and O mucoids such as arises when a purified 'A-substance' is obtained from commercial hog mucin. The very similar chemical and physical properties and behaviour of the specific blood-group factors, and of the closely related but inactive mucoids which undoubtedly occur in native tissue fluids and secretions, forced one to rely on serological techniques for their differentiation, and it has been found that the success or failure of special techniques elaborated to separate the mucoids in mixtures of this kind can be readily followed by determining, by means of quantitative inhibition tests, the ratio of the activity of the appropriate specific characters, in this instance the A and O activity, of the separate fractions obtained. Inactive mucoids, that is, those not possessing A, B or O specificity, can be detected in the presence of material showing these specific blood-group characters by means of this type of agglutination test.

The behaviour of electrophoretically homogeneous hog mucin 'A-substance' after fractionation from solution in water, formamide, ethylene and diethyleneglycol, 90 per cent acetic acid–ammonium acetate mixture (a method investigated in this Institute by Dr. H. Laurell) and 90 and 95 per cent phenol, has revealed that at least a partial separation of the A and O components can be achieved by the use of some of these simple procedures.

Full details of this work and the application of the techniques to artificial and natural mixtures of biologically important mucoid substances will be given elsewhere.

D. Aminoff
W. T. J. Morgan
W. M. Watkins

Lister Institute of Preventive Medicine,
London, S.W.1.
Nov. 16.

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Effect of Cholera Filtrate on Red Cells as Demonstrated by Incomplete *Rh* Antibodies

RED cells sensitized with an incomplete (blocking) anti-*Rh* antibody will agglutinate if suspended in serum[1,2] or in concentrated albumin[3], or, having been washed, are exposed to an anti-human precipitating serum[4]. During an investigation in which the properties of red cells from cases of acute acquired hæmolytic anæmia were compared with red cells 'changed' by a filtrate of a broth culture of cholera vibrio, it was found that red cells previously sensitized by an incomplete antibody, and washed, were agglutinated after incubation with the cholera filtrate. Normal cells when so treated do not show any alteration until they are in contact with serum, when they show panagglutination as in the Hubener Thomsen phenomenon[5]. The 'T' agglutinin responsible for the panagglutination is present in all normal sera and can be specifically absorbed by 'changed' cells; when incomplete anti-*Rh* sera are so absorbed and incubated with red cells, together with cholera filtrate, they show specific agglutination of *Rh*-positive cells. These reactions are shown in the accompanying table.

	Cell type *Rh*+	Cell type *Rh*−
Cholera filtrate + red blood cells + non-immune serum	+	+
Cholera filtrate + red blood cells + non-immune serum ('T' agglutinin absorbed)	−	−
Cholera filtrate + red blood cells + incomplete anti-*D* serum	+	+
Cholera filtrate + red blood cells + incomplete anti-*D* serum ('T' agglutinin absorbed)	+	−
Incomplete anti-*D* serum + red blood cells (washed after incubation) + cholera filtrate	+	−
Incomplete anti-*D* serum + red blood cells (washed after incubation) + anti-human precipitating serum	+	−

The absorption of the 'T' agglutinin does not alter the reactions or the titres of the isoagglutinins or immune agglutinins; nor does incubation of the incomplete anti-*Rh* serum with cholera filtrate change the serum into the complete or agglutinating form. Absorption experiments show that the cholera filtrate does not affect any known hæmagglutinogen loci on the red cell, but Burnet *et al.*[6] have shown that it removes the virus receptors. The factor in the filtrate responsible for changing the red cells is adsorbed on them, and after acting on them is released again, and can be recovered in saline. The saline extract can 'change' further red cells, and also causes agglutination of sensitized cells. Heating to 56° C. for 30 min. diminishes activity. From its reactions it appears to have the properties of an enzyme, possibly a lecithinase which has been described in cholera filtrate by Felsenfeld[7], but preliminary work on the saline extract by Miss M. G. Macfarlane, at the Lister Institute, London, failed to reveal any lecithinase activity.

Four strains of cholera vibrio (stock strain of the Department of Pathology, Oxford, and National Type Cultures Nos. 1548, 4693 and 5596) have been tested, and all except No. 1548 showed activity: of two strains of El Tor (stock strain of the Department of Pathology, Oxford, and National Type Culture No. 4714) only the former showed activity. All were grown for 48 hours in peptone water at *p*H 7·2. The Oxford strain of cholera vibrio has been tested with twenty incomplete anti-*D* and one incomplete anti-*c* serum, and has given specific reactions in parallel with the human albumin and Coombs' tests. It has also given positive results in cases of *in vivo* sensitization in hæmolytic disease of the new-born, and in cases of acute acquired hæmolytic anæmia.

There is complete agreement between the two facets of activity of this factor, which appears to act on some locus of the red cells, the removal of which apparently allows the incomplete antibody to form a further link. It is not a normal second stage of the agglutination reaction, but it may help to give some explanation of this. In the Coombs' test, the agglutination of sensitized cells does not appear to depend on a specific human globulin group, as Simmonds[8] has shown that other mammalian precipitin sera act equally well. There is not, however, agreement in the loss of virus receptors and the panagglutinating property, as Burnet has found that Freidenreich's panagglutinating strain *M* does not cause loss of virus receptors, and a partially purified α-toxin of *Cl. Welchii* Type *A*, though removing virus receptors, does not show panagglutinating properties.

It is not suggested that this test has any real advantages over the Coombs' and human albumin tests for the routine detection of incomplete anti-*Rh* antibodies, but it may help to show the mechanism of agglutination of immune hæmagglutinins and the relationship of the agglutinating to the blocking forms. Further work on the reactions from this point of view is proceeding.

M. M. PICKLES

Division of Laboratories,
Radcliffe Infirmary,
Oxford.
Nov. 11.

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Influence of Heteroauxin on the Cotyledons of *Phaseolus vulgaris* L.

BY smearing cotyledon buds of *Phaseolus vulgaris* (var. non plus ultra) sprouts with heteroauxin paste ($C_{20}H_{18}O_{11}N_2$ + lanolin) so that the cotyledon stalks also come into contact with it, we obtain a prolongation of life of these stalks, which grow longer and larger and remain fresh green, while the rest of the cotyledons afterwards shrivel and change colour (Fig. 1).

This is a similar phenomenon to that observed by May[1] with the leaf stalks of *Coleus* and other plants by addition of pollen auxin, after removal of their lamina.

On the contrary, plants which were treated with lanolin only and untreated plants did not show the above-mentioned results.

In order to observe exactly the influence of heteroauxin on bean cotyledons, experiments were made on these organs of *Phaseolus vulgaris* cultivated in daylight on wet filter-paper, after they had been isolated by breaking or cutting off and smeared partly with heteroauxin paste and partly only with lanolin or untreated for the purpose of control.

The consequence was the formation of calluses which appeared in the three different cases in the following percentages: 98·3 per cent on the

Fig. 1. Effect of heteroauxin on cotyledon stalks

a *b* *c*

Fig. 2. Isolated cotyledons: *a*, controls; *b*, treated with lanolin; *c*, treated with heteroauxin, showing biggest calluses and sprouting of roots

h (heteroauxin) cotyledons; 88·1 per cent on the *l* (lanolin); 85·5 per cent on the untreated *c* cotyledons (control). But the heteroauxin not only increased the growth of the calluses, it accelerated also their development: 66·8 per cent of the *h* cotyledons formed calluses earlier than the *l* cotyledons; 78·9 per cent of the *h* cotyledons formed calluses earlier than the *c* cotyledons; 33·3 per cent of the *l* cotyledons formed calluses earlier than the *c* cotyledons.

The biggest calluses (size of a pea) were found exclusively on the *h* cotyledons (Fig. 2). Also the sprouting of roots was much stronger on the *h* cotyledons (47·1 per cent) than on the *l* cotyledons (3·2 per cent) and the control cotyledons (2·6 per cent) (Fig. 2).

The cotyledons smeared with heteroauxin were for a longer time turgid and appeared in a better state than all the others of the same age.

The conclusion from these observations is that the use of heteroauxin on isolated bean cotyledons causes a considerable prolongation of life and a growth in size as well as a remarkable increment in the development of callus tissue and roots.

A. Malabotti

Institute for Biological Research,
Academy of Science,
Vienna.

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Sphacelial Stage in the Life-history of *Claviceps purpurea* (Fr.) Tul.

In a previous communication my associate and I[1] recorded for the first time successful artificial production of ergot sclerotia of high alkaloid content (total alkaloid content 0·32 per cent, ergometrine content 0·07 per cent) in the tropical plains of Bengal. Ergot, it may be stated here, has long been known to grow naturally at high altitudes and under temperate conditions of such countries as Spain, Portugal, Baltic States, etc. Reports of the artificial production of ergot sclerotia in situations akin to their natural habitats are known from Australia[2] and at Nilgiri Hills, Madras (India)[3].

While attempts in Australia[2] are meeting with indifferent results from year to year, our investigations here for the last two years are giving constant results and yield of high alkaloid contents.

Fig. 1. Sclerotia showing 'honey dew' at base. Natural size

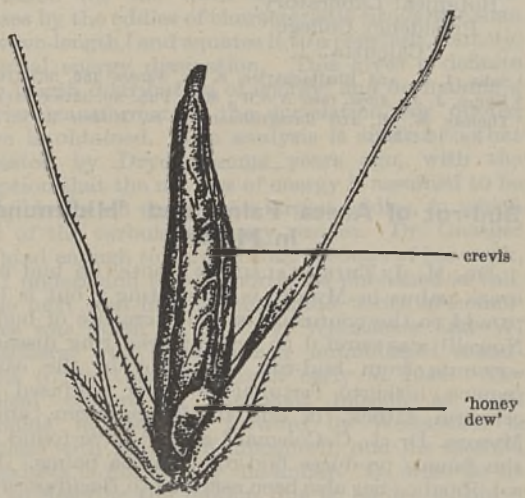

Fig. 2. Mature sclerotium (1½ nat. size)

The following are some hitherto unrecorded observations on the ergot fungus (*Claviceps purpurea* (Fr.) Tul.) under tropical conditions of its growth.

(1) The sphacelial phase of the fungus did not end with the usual 'honey-dew' stage after a period of a week or two of the initiation of the sclerotium formation, but continued up to the time of its (sclerotium) harvest in the crevices on the sides of sclerotium near its base (Figs. 1 and 2). Small drops of 'honey' containing the sphacelial (conidial) spores were observed on the crevices near the base of the sclerotium partly enclosed under the covers of the glumes. This should be termed the secondary sphacelial stage. The spores of this secondary sphacelial stage were akin in all respects, including their viability, with those of the primary sphacelial stage.

(2) Sclerotia, apparently air-dried at the time of harvest, when stored in laboratory without additional sunning in not thoroughly dry glass-stoppered bottles, were soon found to be covered with a white downy growth. These growths, when examined under the microscope, were found to consist mainly of conidial spores of *Claviceps purpurea* (Fr.) Tul., together with a few mycelia. These conidial spores are more lanky than those of the 'honey dew' stage.

It appears that high humidity and high temperature favour continued production of conidial spores and so the continuation of the sphacelial stage.

The average monthly figures for minimum and maximum temperatures and humidity percentage for the period under observation are given in the accompanying table.

Period 1946	Temperature		Humidity		
	Min. ° F.	Max. ° F.	8 hr. I.S.T. %	12.30 hr. I.S.T. %	17 hr. I.S.T.* %
January	54·4	80·6	79·8	34·6	42·1
February	63·8	90·1	85·1	37·1	40·7
March	70·5	93·9	70·3	30·5	36·5
April	73·9	91·9	82·5	55·2	63·2

* I.S.T. (Indian standard time) is 5 hr. 30 min. behind Greenwich mean time.

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J. C. Saha

Botanical Laboratory,
Presidency College,
Calcutta.

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Bud-rot of Areca Palms and 'Hidimundige' in Mysore

Dr. M. J. Thirumalachar's note[1] on bud rot of areca palms in Mysore is interesting; but is likely to add to the confusion in the literature of bud-rot. Nowell[2] was careful to separate red ring disease of coconuts from bud-rot. Bud-rot in the eastern tropics, hitherto fortunately never confused with eelworm attack, is due to *Phytophthora*, and in Mysore, Dr. L. C. Coleman[3] and I[4] have found that the fungus produces bud-rot of areca palms. Bud-rot of palms has also been ascribed to *Bacillus coli*. It is only secondary in red ring.

The 'Hirethota' disease of areca palms differs in almost every respect from red ring of coco-nuts, as seen below.

Hirethota disease	Red ring disease
1. No yellowing or wilting of pinnæ.	Yellowing and wilting of pinnæ.
2. Green nuts not shed.	Green nuts in all stages of immaturity shed.
3. Leaves shed, bud and crown rot, leaving bare stem.	Leaves not shed, crown not involved in rot.
4. Nema present in vessels of vascular bundles.	Infestation confined to the ground tissue; vascular bundles unaffected in any way.
5. Spread of disease slow, extending over several years.	Rapidity of infestation, in 60–70 days.
6. No red ring in stem.	Red ring present in stem.
7. Copious flow of evil-smelling liquid containing nema.	No ooze.

In spite of the absence of the red ring, the most characteristic symptom, Dr. Thirumalachar identifies the disease with red ring on the plea that it might be symptomatic of the particular host.

In citing references, Dr. Thirumalachar has allowed several inaccuracies to creep in. He says that Nowell and Briton-Jones pointed out the untenability of Johnston's conclusion that bud-rot of coco-nuts is caused by *Bacillus coli*. Briton-Jones alone did that. He attributes to Nowell what Briton-Jones says about various modes of spread of the disease by fauna frequenting the crowns of coco-nut palms. Because seedlings distributed from Hirethota are reported to have transmitted the disease, he accepts what Nowell only conjectured, that fallen nuts may harbour the worms, and concludes that the disease is infectious and is possibly transported by some fauna. The disease is common on old trees, about ten years of age, and is rare on young palms, and to suggest that it occurs at that stage owing to transmission by the seedling is a little far-fetched. According to Nowell[2], "the rapidity of infestation shown in the infection experiments renders untenable the hypothesis first put forward that infection takes place at an early age without its effects becoming outwardly visible until the tree matures". 'Hidimundige' is present in very widely separated localities where there is no suspicion of its having spread from one centre. Dr. Thirumalachar states that red wing was first described from the British East Indies by Nowell, which is obviously a mistake. In the next sentence, however, he refers to its distribution in the western hemisphere.

Some work has been done in this department on the 'hidimundige' of areca palms. The tops of diseased trees show an internal injury in the crown in the form of a longitudinal cut extending from the top of the stem to a greater portion of the bud, with no outside injury. The inflorescences are attacked even as they are formed, and decay. Affected trees never bear fruit. The crowns dry up within about six to eight months of the attack, and in the affected tissues a saprophytic *Fusarium* and some bacteria occur. In some of the affected palms from Hirethota I noticed an enchytræid worm, but was not sure if it was pathogenic.

S. V. Venkatarayan

Department of Agriculture,
Bangalore,
Mysore.
Oct. 28.

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DOUBLE VELOCITY CORRELATION FUNCTION IN TURBULENT MOTION*

By G. K. BATCHELOR
Trinity College, Cambridge

SINCE 1941 there have been three independently proposed developments in the theory of turbulent motion leading to substantially the same results. The most important of these common results is that as the Reynolds number of homogeneous isotropic turbulence increases indefinitely, the coefficient of correlation between parallel velocity fluctuations at two points distance r apart approaches the form $1 - Ar^{2/3}$ (A = const.), provided r is small compared with the integral scale of turbulence (L). This result was obtained (1) by A. N. Kolmogoroff in 1941, publication in *C.R. (Doklady) Acad. Sci. de l'U.R.S.S.*, (2) by L. Onsager in 1945, publication (in abstract) in the *Physical Review*, and (3) by C. F. v. Weizsäcker, in collaboration with W. Heisenberg, in 1946, as yet unpublished. The purpose of this short note is to direct attention to these results, since none of the authors is at the present Congress.

The three theories have certain elements in common, sometimes explicit and in some cases implied. These are: (1) the assumption of indefinitely high Reynolds' number of the flow as a whole; (2) the related assumption that the effect of viscosity on velocity correlations is negligible; this is not valid in the immediate neighbourhood of $r = 0$ where the double velocity correlation is parabolic, but this region becomes vanishingly small as the Reynolds' number increases; (3) the energy which can be imagined to be associated with a small range of wave numbers is received chiefly from wave numbers one order smaller (that is, eddies of larger size), and in turn passes on to larger wave numbers without loss through viscous dissipation; (4) the motion of the smallest existing eddies (of vanishingly small diameter) is entirely laminar and is responsible for most of the energy dissipation of the turbulent motion. These points are part of a physical picture of the turbulence which is roughly identical in the three theories. However, the mathematical formulations vary considerably.

The neatest and most powerful formulation of the physical ideas is that of Kolmogoroff. In order to be able to isolate the statistical effect of eddies of a certain range of sizes, Kolmogoroff first constructs a kinematical theory of correlations between the *differences* of parallel velocity fluctuations at two points. He supposes that the motion due to all eddies smaller than some suitable limiting size is isotropic, irrespective of the nature of the mean flow, and also statistically steady. This limitation of the size of the eddies considered is fundamental, and the limitation is achieved mathematically by restricting the distance r between the two points on which the velocity differences are based. Kolmogoroff next puts forward two similarity hypotheses, suggested by the physical picture of the turbulence at high Reynolds' numbers, from which the statistical characteristics of the motion due to these eddies can be deduced. The first asserts that the statistical characteristics depend only on the two quantities, viscosity (ν) and mean energy dissipation per unit mass of the fluid (ε). The second asserts that the statistical characteristics of the motion due to the larger of the eddies contained within the limit mentioned above depend only on one of these quantities, namely, the energy dissipation (ε).

Using dimensional considerations, it is then possible to construct the general form of the various correlations between velocity differences. The second similarity hypothesis leads, in the case of homogeneous turbulence, to the result mentioned above, that the double (parallel) velocity correlation coefficient varies as $1 - Ar^{2/3}$ for $\eta \ll r \ll L$, where η is a measure of the size of the smallest existing eddies; for guidance in the proof, note first that A has dimensions $(\text{length})^{-2/3}$, that is, $(\text{velocity})^{-2} \times (\text{energy dissipation per unit mass})^{2/3}$, and secondly, that the similarity hypotheses apply to the velocity correlations themselves, and not to the coefficients. There are very few correlation measurements at high Reynolds' number with which this theoretical prediction can be compared, but there are other predictions from Kolmogoroff's similarity hypotheses which clearly have the correct form. One prediction not hitherto compared with experiment is that the skewness factor, formed from the second and third moments, of the probability distribution of the rate of extension in any direction is a universal constant. Measurements which confirm this prediction have been made at Cambridge; details are contained in a paper presented to this Congress.

The approach of Onsager is very different. This author represents the spatial distribution of velocity in isotropic turbulence by a three-dimensional Fourier series, that is, the motion is divided up among a number of wave-lengths. From the equations of motion he then finds an expression for the rate at which energy is transferred from one wave-length to another. This expression is such as to suggest the 'cascade' process whereby the energy movement from any wave-length is chiefly to neighbouring shorter wave-lengths, and eventually to the smallest wave-lengths where the motion is laminar. In the limit of very high Reynolds' number, the amount of energy received by any wave-length (which is neither very small nor very large) per second is equal to the amount passed on, and the amount of energy lost by all wave-lengths larger than l, say, is independent of l. On the basis of these notions, Onsager constructs an expression for the work done against Reynolds' stresses by the eddies of characteristic size larger than the wave-length l and equates it to a constant, namely, the total energy dissipation. This gives a definite wave-length distribution of energy, and on making a Fourier transformation the correlation law quoted above is obtained. The analysis is similar to that suggested by Dryden some years ago, with the exception that the net loss of energy is assumed to be negligible for all except the largest eddies, in which most of the turbulent energy resides. Dr. Onsager was kind enough to show me an account of his work, and I understand it will shortly be published in full.

The next step in this remarkable series of coincidences was taken by C. F. v. Weizsäcker and W. Heisenberg, who showed their unpublished manuscripts to Sir Geoffrey Taylor early in 1946. The physical picture of turbulent motion at high Reynolds' number put forward by Weizsäcker is identical with that of Kolmogoroff, and his method of analysis is not wholly dissimilar. In order to be able to describe the motion due to eddies within a small range of sizes, Weizsäcker divides the region of

* A contribution to the Turbulence Symposium at the Sixth International Congress for Applied Mechanics held in Paris during September 22–29.

isotropic turbulence into a number of cubes. Each of these cubes is again divided into a certain integral number of cubes, and so on, with a constant ratio between the sizes of cubes of neighbouring order. The characteristic velocity of eddies of dimensions L_n is then given by v_n, the root-mean-square of the velocity of fluid within the cube of side L_n relative to that within the cube of next larger size (L_{n-1}) containing the cube L_n. On dimensional grounds the work done against Reynolds' stresses created by the turbulent motion of cubes of side L_n is written as proportional to v_n^3/L_n. This represents the rate of energy loss of all eddies larger than L_n and, in virtue of the assumption that viscous dissipation losses are confined to the smallest eddies, must be independent of n. The energy associated with the cubes of side L_n is then proportional to $L_n^{2/3}$, and the energy per unit wave-number (k) is proportional to $k^{-5/3}$; the now familiar double velocity correlation function is obtained from a Fourier transformation. Heisenberg has repeated Weizsäcker's analysis in terms of Fourier series, and has extended it to obtain other results of interest, which will probably be described in a German publication. He finds a moderately good agreement between the theoretical spectrum law and measurements made by Simmons.

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RECENT MARINE BIOLOGICAL RESEARCH

THE recent volume of the *Journal of the Marine Biological Association** is of normal size and quality and is a reminder that once again we can pursue and enjoy knowledge for its own sake.

Prof. A. C. Hardy contributes a moving tribute to a great leader in his obituary notice of Dr. Stanley Kemp, the director of the Marine Laboratory at Plymouth. Every zoologist should read it; to his friends it will bring happy memories of Dr. Kemp's enthusiasm, energy, modesty and whole-hearted devotion to his subject, and to those who had not the privilege of knowing him an example and an inspiration. Dr. Kemp fully maintained the tradition of the Plymouth Laboratory, initiated by the late Dr. E. J. Allen on the lines of Anton Dohrn's Laboratory at Naples, of interesting himself directly in the widely different fields of research being followed by the permanent and visiting workers at the Laboratory. Mr. D. P. Wilson adds a graphic account of the night of the raid (March 20, 1941) when Dr. Kemp lost his home and all his possessions, including his collection of antique furniture, his books, and all the material and manuscript notes of a work on the "Discovery" deep-water decapod Crustacea. The Laboratory was damaged by high explosive; but the fire from Dr. Kemp's house was prevented from spreading, and before the ashes had cooled, he was planning for the future. Yet who can doubt that the strain of that night undermined his strength. We are indebted to Dr. J. H. Welsh, of Harvard University, for the excellent photograph of Dr. Kemp which forms the frontispiece of the volume.

The scientific contributions fall into four groups: phytoplankton, biochemistry, zoology and fisheries.

Phytoplankton. Mr. D. P. Wilson describes triradiate and other forms in *Nitzschia closterium*, using sub-cultures from the thirty-six year old stock founded by Allen and Nelson in 1910. All these forms may pass into one another by division, but the preponderance of the larger types may be detrimental when minute larvæ have to be fed.

Mr. R. S. Wimpenny examines the varieties of *Rhizosolenia styliformis* and considers that this cosmopolitan species has three forms, which he calls *longispina* (the type of the species), *oceanica* and *semispina*.

Biochemistry. Mr. S. P. Chu studied the utilization by phytoplankton of organic phosphorus. Only dissolved phosphorus can be used directly by plants, and so little is known of the phosphorus cycle in the sea that it was assumed that only phosphate could be absorbed by marine plants. Diatoms can utilize inorganic orthophosphate in solution, but Chu found that though pyrophosphate cannot be used as effectively as orthophosphate, phytin was more successful, and organic forms of phosphorus can be broken down by diatoms and used directly. It is thus possible to construct a phosphorus cycle on the same lines as the nitrogen cycle for living beings in the sea.

Zoology. Dr. Vera Fretter adds another paper to her series on the combined anatomy, histology and physiology of molluscs by a study of the genital ducts of *Theodoxus*, *Lamellaria* and *Trivia*, with a discussion of their evolution in prosobranchs.

Mr. H. G. Q. Rowett contributes a paper on the feeding mechanisms of the nudibranch *Calma glaucoides* and the crustacean *Nebaliopsis typica*. The former is known to feed on the eggs of various shore-living fishes; the latter, a deep-sea form, has not been seen feeding, but its gut contents are of a rich yolky nature, and it is therefore suspected of taking fish eggs from the sea bottom. In *Calma*, the radula and jaws nip the egg membrane and suck its contents, but in *Nebaliopsis* the egg must be taken past the weak mandibles into the tough œsophagus, and there split and sucked. Thus two widely separated animals have evolved feeding arrangements which are similar in plan.

Prof. C. M. Yonge has three papers in this volume, two on the habits of the lamellibranch *Aloidis* (*Corbula*) *gibba* and the gastropod *Turritella communis* respectively, and the third on the membranes surrounding the eggs of *Homarus vulgaris*. *Aloidis* anchors itself by a single byssus thread to a gravel stone on a coarse mud bottom, burrowing until only the short siphons are protruded. Ciliary currents collect debris, bacteria and diatoms, mixed with considerable quantities of inorganic matter, the last expelled forcibly as pseudo-fæces by means of a

* *Journal of the Marine Biological Association of the United Kingdom*, 26, No. 3, 1946 (Cambridge University Press). 25*s*.

quick-acting portion of the adductor muscles. Even the foot can be pushed through the inhalant aperture to clear the sediment.

Another bottom feeder is *Turritella communis*. Graham (1938) described its method of ciliary feeding, and the formation, unique among Prosobranchs, of a siphon formed by two folds of the body wall, and used for the expulsion of fæces. Yonge found that the mollusc burrows diagonally into thick muddy gravel, then with its foot pushes the mud away from the left side of the head, making an inhalant depression. The displaced mud accumulates in a small mound which piles up in front of the head and is agglutinated by secretion of the pedal gland. Head and foot are then withdrawn below the surface, water and small organisms are drawn in by ciliary action into the left side of the mantle cavity, and water and fæces expelled on the right through the 'siphon'.

Dr. Lebour clears up the confusion which existed regarding the species of *Teredo* from Plymouth waters by a careful study of living material. She describes three species, *T. norvegica* and *navalis* from the experimental raft moored near Plymouth Breakwater, and *T. megotara* occurring occasionally in driftwood. Development within a brood pouch takes place in *T. navalis* only.

Mr. D. W. Ewer describes a variety of *Sabella pavonina* from Plymouth, previously named by Hornell (1891) *S. pavonina*, var. *bicoronata*, from Hilbre Island, near Liverpool. In this variety the number of filaments on the two sides of the branchial crown is unequal. Since inequality in the number of filaments in *Spirographis* was the only positive character distinguishing it from *Sabella*, that distinction is no longer valid, and both should be united under *Sabella*, as re-defined.

Mr. D. P. Wilson's photographs of living marine animals are well known, and to this series he adds an excellent set of *Sepia officinalis* stalking, capturing and consuming a prawn. The action of the tentacles in gripping the prey is shown, and of great interest are the colour changes in the skin. *Sepia* blushes when in pursuit, but pales when the prey is caught and transferred to the mouth.

Fisheries. Mr. E. Ford discusses vertebral variation in isospondylous fishes. This is Part 3 of his series on this subject, and includes the families Clupeidæ, Salmonidæ and Argentinidæ. He directs attention to the diagnostic value of vertebral counts, to the siting of other structures relative to the backbone elements, and to the marker characters which provide the means of recognition on sight.

Two papers by Mr. C. F. Hickling deal with haddock and herring fishing. He studied the self-contained stock of haddock on the Porcupine Bank, off the west coast of Ireland. The Bank had complete immunity from trawling, owing to the War, from 1940 until 1944, with the result that it now carries "the densest stock of haddock ever experienced there". There was no evidence that overcrowding had slowed the rate of growth.

The herring fisheries carried on from Milford Haven provide herrings nearly all the year round. There are a winter and spring drift net fisheries, and summer and autumn trawl fisheries. As evidence indicates that all are based on the same stock of herrings, this area should provide "a fruitful field of work for the study of the seasonal cycle of the herring".

N. B. Eales

PLANT VIRUSES

SEVERAL recent papers from the Department of Plant Pathology, Rothamsted, and from the Council for Scientific and Industrial Research of Australia, make an impressive collection of new knowledge about virus diseases of plants. F. C. Bawden and N. W. Pirie[1] show that sap expressed from the leaves of tobacco plants infected with mosaic contains less than one third of the total amount of virus in the plant. The additional virus can be liberated by successive incubations with commercial trypsin, or, even more successfully, with the mixture of enzymes obtained from crops of the snail *Helix aspersa*. Subsequent fine grinding releases even more virus, which was found to account in all for one third of the total insoluble nitrogen in the leaf, or 10 per cent of its dry matter. J. B. Hale, M. A. Watson and R. Hull[2] discuss "some causes of chlorosis and necrosis of sugar-beet foliage". They describe the symptoms and characteristics of two viruses, one fungus disease and four nutritional disorders of the crop, combining analytical and pathological methods with field experiments. Sugar-beet yellows and manganese deficiency can be distinguished visually, according to the authors, but a little more clarity of comparison would be welcome. The paper is, however, a vigorous attempt to place the field recognition of sugar-beet diseases on a surer basis than hitherto, but still leaves the impression that the advisory pathologist requires the backing of chemist and virus etiologist. A new species of shallot aphis, *Myzus ascalonicus*, is described by J. P. Doncaster and B. Kassanis[3]. The aphid resembles *Myzus persicæ*, and is also a vector of plant viruses. Both the species transmit cucumber virus I, *Hyoscyamus* virus III and sugar-beet yellows virus. *M. ascalonicus* transmits dandelion yellow mosaic, whereas *M. persicæ* does not, though the latter aphid transmits potato *Y* virus, lettuce and sugar-beet mosaics, and severe etch virus, for which *M. ascalonicus* is not a vector. Here is further knowledge for use in virus analysis.

Potato varieties differ considerably in their susceptibility to insect transmission of virus *Y*[4]. The American variety Katahdin was found to be most resistant, while Majestic and Arran Banner were the hardest of British varieties to infect. Ulster Monarch was the most susceptible variety investigated. The concentration of virus varied in different varieties. E. M. Hutton, working in Australia[5], approaches the question of resistance to virus *Y* from the genetic angle. He has isolated fifteen phenotypes which are hypersensitive to the virus. They produce varying degrees of necrosis, following mechanical inoculation with virus *Y*. The variety Katahdin is here a source of hypersensitivity, and it seems necessary for more research to be performed, in order to link the English and Australian findings; methods of inoculation are not the same, and this may provide an explanation. J. G. Bald and C. E. W. Oldaker[6] describe the reactions of the varieties Brownell and Silverskin Bismark to viruses *A*, *X*, *Y* and leaf-roll. Brownell is a carrier of virus *X*, is immune to virus *A* in the field, and is susceptible to leaf-roll. Bismark is resistant to leaf-roll, but is susceptible to a 'crinkle' caused by a combination of viruses *X* and *A*. The old Australian potato variety, Brown's River, has yielded a virus now identified by J. G. Bald and D. O. Norris[7] as virus *C*. It has many properties similar to virus *Y*, but is not readily transmitted by *Myzus persicæ*, the main vector of virus *Y*. J. G.

Bald[8] also finds that potato rugose mosaic (viruses $X+Y$) reduces the yield to about 50 per cent that of healthy plants, and the reduction is proportional to the diminution of leaf area caused by the disease.

The economic significance and complex nature of the virus problem make it one of the major challenges to modern biological investigation. A patient amassing of the facts, as typified by the eight papers here reviewed, is manifestly the only sure way of approach, and it is not until this is accomplished on a wide scale that any great practical results can be expected.

JOHN GRAINGER

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BANANA LEAF SPOT

THE leaf spot disease of bananas, caused by *Mycosphærella musicola* Leach (*Cercospora musæ* Zimm.), long known as a destructive malady in the Australasian region, was not observed in the New World until 1934, when a small outbreak was observed in Trinidad. This was soon followed by news of the disease in Suriname, Jamaica and Central America, and the Caribbean region generally. In the course of the few years during which the disease waxed to epidemic proportions it was under constant observation. Hence it may fairly be claimed that among plant epidemics the leaf disease of bananas is among the most fully documented and best known scientifically. The progress of the disease has been marked by a number of important advances in our knowledge, such as the details of infection, the progressive development of symptoms in plantations, and the ultimate effects of the disease on commercial fruit intended for refrigerated transport overseas. Not least important, as a result of imaginative innovations on a gigantic scale, the large fruit companies operating in Central America showed how the disease could be controlled by frequent spraying with appropriate fungicides.

The Colony of Jamaica, with its many and varied types of banana plantation, large and small, on hillside and plain, presented special difficulties in the matter of disease control. It was realized that further investigations both of a fundamental and applied character were necessary if rational control measures were to be forthcoming. To this end Mr. R. Leach was appointed as mycologist for the investigation of leaf disease. His report, the result of four years of work, is now before us (R. Leach, "Banana Leaf Spot", Dept. Agric. Jamaica, Govt. Printer, Kingston, pp. 118, illustrated, 2*s*.). This work, largely based on direct field studies of the pathogen, covers a great deal of new and interesting ground and can only be dealt with summarily here. What, in brief, Leach set out to do was to obtain, by direct observation and experiment, a comprehensive knowledge of the main features of the disease on which basic principles of control could be developed. In the course of these studies, not only was the ascigerous stage of the pathogen discovered, but also it was found that there were differences in symptoms between ascospore and conidial infections; and that a peculiar relationship existed between soil conditions and the type of fructification produced in the leaf spots. Certain soil conditions, which affect the metabolism of the leaves, are attended by the development of an abnormally large number of perithecia throughout the year, ascospore infection being reduced only during the colder months. The adverse soil factors include poor aeration, marked fluctuations in the oxidation/reduction conditions, and shallow tilth layers. Hence the importance, particularly in Jamaica, of measures designed to conserve fertility by attention to drainage, maintenance of soil structure, etc.

The details of spot development, and their distribution on the leaf surface; the development, dissemination, germination and viability of spores; the factors affecting infection; the principles of control by spraying; the seasonal variation in disease intensity; and other matters have been the subject of close observation and experiment, the whole constituting a substantial body of fact and a real contribution to our knowledge of this important disease. Mr. Leach and the Jamaica Department of Agriculture are to be congratulated on having carried through to a successful conclusion this difficult and comprehensive series of investigations.

C. W. WARDLAW

FORESTRY IN UGANDA

IN the annual report of the Uganda Forestry Department for the year 1945 (Government Printer, Uganda, 1946), the objectives of the forest policy are laid down: first, to reserve in the State sufficient land either already under forest or capable of afforestation to maintain climatic conditions suitable to agriculture; to preserve water supplies; to provide forest produce for the agricultural industrial development, and to maintain soil stability in areas where the land is liable to deterioration if put to other uses; secondly, to manage the forest property of the State to the best financial returns, such as are consistent with the primary aims set out above; to encourage and assist the practice and science of forestry by native authorities, and private enterprise; and lastly, to foster by education and propaganda a real understanding among the people of Uganda of the value of forests to them and to posterity, and to educate selected Africans in technical forestry.

These objects and ambitions have been enumerated in one form or another in the British Empire ever since the Indian Forest Service was formed more than eighty years ago. In many parts of the Empire, however, extraordinarily little progress has been made, and by its unchecked utilization of available timber supplies both in and outside the Empire, which the late War necessitated, the attainment of these objectives might seem to be farther off than ever. But the institution of conservation boards in connexion with agriculture and forestry in many parts of the world gives hope that at length the policy so well outlined above, which practically covers the whole of the aims and objects of forestry, will be given effect to; and above all that the close interrelation between forestry and agriculture will at length be given some measure of recognition in Africa, both West and East.

It is a credit to Uganda that its Forestry Department is among the first to write and publish effective working plans for some of its forest areas. Local plans produced for local areas but not made public

afford little information as to the progress being made by a forestry department. As a last resort, professional progress of any standard is made manifest by means of a printed and published working plan, and in this Uganda has apparently taken a lead.

FORTHCOMING EVENTS

Monday, December 16

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS, BIOLOGICAL METHODS GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Annual General Meeting; at 6.30 p.m.—Miss H. M. Bruce: "The Assay of Anti-Thyroid Substances using Tadpoles"; Mr. E. C. Wood: "The Computation of Microbiological Assays of Amino-Acids and other Growth Factors".

INSTITUTION OF THE RUBBER INDUSTRY, MANCHESTER SECTION (at the Engineers' Club, Albert Square, Manchester), at 6.15 p.m.—Mr. J. M. Buist and Dr. D. A. Harper: "The Revision of British Standard Specifications for Vulcanised Rubber".

SHEFFIELD SOCIETY OF ENGINEERS AND METALLURGISTS (at the Royal Victoria Hotel, Sheffield), at 6.15 p.m.—Dr. Hugh O'Neill: "Some Recent Problems for Railway Metallurgists".

CHEMICAL SOCIETY, LEEDS BRANCH (in the Chemistry Lecture Theatre, The University, Leeds), at 6.30 p.m.—Prof. Harold C. Urey: "Isotopes".

Tuesday, December 17

ROYAL SOCIETY OF ARTS, DOMINIONS AND COLONIES SECTION (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Rt. Hon. Lord Elton: "The Work of the Rhodes Trust".

EUGENICS SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. J. W. B. Douglas: "Social and Economic Problems of Childbearing in Britain—Report of a Questionnaire Inquiry".

INSTITUTE OF PHYSICS, ELECTRONICS GROUP (in Room 87, The Polytechnic, 309 Regent Street, London, W.1), at 5.30 p.m.—Prof. W. V. Mayneord: "Applications of Nuclear Physics in Medicine".

SHEFFIELD METALLURGICAL ASSOCIATION (at the Metallurgical Club, 198 West Street, Sheffield), at 6.30 p.m.—Dr. J. White: "The Physical Chemistry of Steelmaking Reactions".

SOCIETY OF DYERS AND COLOURISTS, HUDDERSFIELD SECTION (at Field's Café, Huddersfield), at 7.30 p.m.—Mr. A. Klinger: "A Survey of Continental Finishing".

Wednesday, December 18

INSTITUTE OF FUEL, YORKSHIRE SECTION (at the University, Leeds), at 2.30 p.m.—Dr. C. C. Hall: "Fischer–Tropsch Process—Present and Future".

CHEMICAL SOCIETY, NEWCASTLE-UPON-TYNE SECTION (joint meeting with the local sections of the ROYAL INSTITUTE OF CHEMISTRY, the SOCIETY OF CHEMICAL INDUSTRY, the INSTITUTE OF CHEMICAL ENGINEERS and the COKE OVEN MANAGERS' ASSOCIATION, in the Chemistry Lecture Theatre, King's College, Newcastle-upon-Tyne), at 6.30 p.m.—Dr. H. C. Craggs and Mr. H. M. Arnold: "Hydrogen Sulphide Removal by Ammoniacal Ferrocyanide Liquors".

CHEMICAL SOCIETY (at the Royal Institution, Albemarle Street, London, W.1), at 7.30 p.m.—Prof. Harold C. Urey: "Some Problems in the Separation of Isotopes" (Eleventh Liversidge Lecture).

SOCIETY FOR VISITING SCIENTISTS (at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—"The New Place of Science in Higher Education" (Speakers: Sir J. E. Lennard-Jones, F.R.S., Prof. R. V. Southwell, F.R.S., Mr. J. T. Saunders and Sir Thomas Merton, F.R.S.).

Thursday, December 19

PHYSICAL SOCIETY, COLOUR GROUP (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 3.30 p.m.—Discussion on the "Report of Defective Colour Vision in Industry" (to be opened by Dr. A. H. Gale, Mr. R. F. G. Holness, Dr. J. Sharp Grant, Prof. L. C. Martin and Dr. M. Abrahamson).

INSTITUTION OF MINING AND METALLURGY (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. W. David Evans: "The Geology and Opencast Mining of the Jurassic Ironstones of Great Britain"; Mr. N. W. Wilson: "Notes on the Estimation of Tonnage and Grade of some Chromite Dumps".

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Symposium on "The Geometry of Numbers" (arranged by Prof. H. Davenport, F.R.S.).

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Dr. John Wishart: "Statistical Aspects of Demobilization in the Royal Navy".

CHEMICAL SOCIETY, SOCIETY OF CHEMICAL INDUSTRY and ROYAL INSTITUTE OF CHEMISTRY, EDINBURGH AND EAST OF SCOTLAND SECTIONS (in the Biochemistry Lecture Theatre, the University, Teviot Place, Edinburgh), at 5.30 p.m.—Prof. Harold C. Urey: "Some Problems in the Separation of Isotopes" (Eleventh Liversidge Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS (joint meeting with the INSTITUTION OF MECHANICAL ENGINEERS, at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. C. H. Sparks: "The Future of Pulverized-Coal Firing in Great Britain".

ROYAL AERONAUTICAL SOCIETY (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Mr. J. Smith: "The Evolution of the Spitfire".

TEXTILE INSTITUTE, YORKSHIRE SECTION (at the Midland Hotel, Bradford), at 7 p.m.—Dr. A. B. Wildman: "The Microscopy of Fibres—Aids to their Identification".

Friday, December 20

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. A. Sykes: "Progress in Turbine Gear Manufacture in Recent Years"; Mr. Cecil Timms: "The Measurement of Errors in Gears for Turbine Reduction Drives".

INSTITUTE OF FUEL, SCOTTISH SECTION (at the Royal Technical College, Glasgow), at 5.45 p.m.—Dr. E. A. C. Chamberlain: "Some Aspects of Domestic Heating Appliances".

SOCIETY OF DYERS AND COLOURISTS, SCOTTISH SECTION (at St. Enoch Hotel, Glasgow), at 7 p.m.—Discussion on the Report of the Committee on "The Dyeing Properties of Direct Cotton Dyes" (to be introduced by Mr. John Boulton).

APPOINTMENTS VACANT

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

LECTURER (man or woman) IN BIOLOGY—The Director of Education, Education Department, The Guildhall, Swansea (December 19).

SCIENTIFICALLY QUALIFIED OFFICER (temporary) in the Blood Transfusion Service in the North-West Region—The Regional Establishment Officer, Ministry of Health Regional Offices, Sunlight House, Quay Street, Manchester 3 (December 21).

ASSISTANT LECTURER IN ENGINEERING in the Bradford Technical College—The Director of Education, Town Hall, Bradford (December 21).

SCIENCE GRADUATE (Zoology) for bureau literary work—The Director, Imperial Bureau of Animal Health, Veterinary Laboratory, New Haw, Weybridge, Surrey (December 25).

ASSISTANT LECTURER IN MATHEMATICS, ASSISTANT LECTURER IN PHYSICS, and an ASSISTANT LECTURER IN CHEMISTRY—The Registrar, University College, Singleton Park, Swansea (December 27).

PROFESSOR OF CIVIL ENGINEERING, PROFESSOR OF MECHANICAL ENGINEERING, and PROFESSOR OF ELECTRICAL ENGINEERING, at the Thomason College of Engineering, Roorkee, U.P., India—The Office of the High Commissioner for India, General Department, India House, Aldwych, London, W.C.2, quoting No. 290 (December 28).

ORGANIC CHEMIST at Long Ashton Research Station—The Secretary and Registrar, The University, Bristol 8 (December 28).

ASSISTANT LIBRARIAN in the Medical Department—The Director, Appointments Department, British Council, 3 Hanover Street, London, W.1 (December 28).

BIOLOGIST, and a JUNIOR ASSISTANT PHYSICIST, in the Biophysics Research Group, and a JUNIOR ASSISTANT PHYSICIST in the Clinical Physics Department—The Secretary, Mount Vernon Hospital and Radium Institute, Northwood, Middx. (December 28).

EXPERIMENTAL OFFICERS (with qualifications in (*a*) Mechanical Engineering, (*b*) Electrical Engineering including radio, or (*c*) Mathematics including preferably aerodynamics), for abstracting and indexing of scientific and technical papers and reports, and an ASSISTANT EXPERIMENTAL OFFICER to assist in a technical library, at the Guided Projectiles Establishment, Westcott, Berks.—The Director of Scientific and Technical Administration (D), Room 27, Ivybridge House, John Adam Street, Strand, London, W.C.2, quoting No. D.1/46 (December 28).

GENERAL SECRETARY—The Secretaries, Chemical Society, Burlington House, Piccadilly, London, W.1 (December 31).

SENIOR LECTURER or LECTURER IN BIOLOGY AND RURAL SCIENCE at the Burderop Park Emergency Training College for Men, Wroughton, Wilts.—The Director of Education, County Hall, Trowbridge, Wilts. (December 31).

RESEARCH ASSISTANT to take part in the Economic Survey of Northern Ireland and its relationship to the economy of Great Britain—The Secretary, Queen's University, Belfast (December 31).

LECTURER IN MINING, and a LECTURER IN ELECTRICAL ENGINEERING, at the Cannock Chase Mining College—The Director of Education (Dept. F.E.), County Education Offices, Stafford (January 1).

ASSISTANT CHIEF CHEMIST (Ref. F.1281.A), and a CHEMIST (Ref. F.1282.A), for large Oil Refinery in the South of England—The Ministry of Labour and National Service, Technical and Scientific Register, Room 572, York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (January 4).

SENIOR POSTS (2) in the Television Section of Research Department—The Engineering Establishment Officer, British Broadcasting Corporation, Broadcasting House, London, W.1 (January 8).

LECTURER IN STATISTICS—The Secretary, The University, Aberdeen (January 15).

SENIOR LECTURER and a JUNIOR LECTURER IN ANIMAL HUSBANDRY at the Imperial College of Tropical Agriculture, Trinidad—The Secretary, Imperial College of Tropical Agriculture, Grand Buildings, Trafalgar Square, London, W.C.2 (January 20).

LECTURER IN CHEMISTRY at Natal University College—The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1.

ENTOMOLOGIST to carry out a survey of the tsetse areas of the Southern Sudan and undertake research work—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Veterinary Entomologist'.

BOTANIST to carry out a survey of the grazing areas of the Sudan—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Pasture'.

LECTURER or ASSISTANT LECTURER IN MATHEMATICS—The Registrar, University College, Exeter.

ASSOCIATE PROFESSOR OF CHEMISTRY AND PHYSICS at the Royal College of Medicine, Baghdad, an EXPERT IN ENTOMOLOGY, an ENTOMOLOGIST, and a SOIL TECHNOLOGIST, to the Government of Iraq—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N.13724.

FISH EXPERT by the Iraqi Government Ministry of Economic Affairs—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N.14573.

SCIENTIFIC JOURNALIST—The Secretary, British Rubber Development Board, 19 Fenchurch Street, London, E.C.3.

EDITORIAL ASSISTANT for the *Journal of the Institution of Electrical Engineers*, and an ASSISTANT LIBRARIAN (man)—The Secretary, Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2.

HORTICULTURAL INSTRUCTOR—The Principal, County Agricultural Institute, St. Mary's Gate, Derby.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

University of London: University College. Annual Report, February 1945–February 1946. Pp. 60. (London: Taylor and Francis, Ltd., 1946.) [126

Ministry of Fuel and Power and British Intelligence Objectives Sub-Committee. Technical Report on the Ruhr Coalfield. By a Mission from the Mechanisation Advisory Committee of the Ministry of Fuel and Power. B.I.O.S. Final Report No. 394. Vol. 1. Pp. vi + 61. (London: H.M. Stationery Office, 1946.) 3*s*. net. [126

Annals of the Solar Physics Observatory, Cambridge. Vol. 3, Part 3: The Distribution and Movements of Solar Prominence Areas. By W. Moss, under the direction of H. F. Newall, and subsequently of F. J. M. Stratton. Pp. vii + 119–128 + 7 plates. (Cambridge: At the University Press, 1946.) 5*s*. net. [126

Ordnance Survey. Booklet No. 1/45: A Brief Description of the National Grid and Reference System. Pp. 12. (London: H.M. Stationery Office, 1946.) 4*d*. net. [136

British Drug Houses, Ltd. Report of the Directors for the Year ended 31st December 1945. Pp. 8. (London: British Drug Houses, Ltd., 1946.) [136

International African Institute. Memorandum 21: The Study of Africa's Past. By Thurstan Shaw. Pp. 24. (London: Oxford University Press, 1946.) 2*s*. net. [136

A Study of the Growth of Grass in 'Surface-Stabilised' Soil. By Martin A. F. Sutton, in collaboration with T. F. N. Alexander and F. C. West. Pp. 28. (Reading: Sutton and Sons, Ltd., 1946.) 3*s*. 6*d*. net. [146

Department of Scientific and Industrial Research: Forest Products Research. A Handbook of Woodcutting. By P. Harris. Pp. 44. (London: H.M. Stationery Office, 1946.) 9*d*. net. [186

National Smoke Abatement Society. Sixteenth Annual Report, 1945. Pp. 20. (London: National Smoke Abatement Society, 1946.) [186

Royal Anthropological Institute. Report of the Council for the Session July 1945 to June 1946. Pp. 16. (London: Royal Anthropological Institute, 1946.) [186

Ministry of Supply. Some Properties and Applications of D.D.T. Pp. 36. (London: H.M. Stationery Office, 1946.) 6*d*. net. [186

Ovaltine Research Laboratories. Annual Report, 1945. Pp. 10. (London: A. Wander, Ltd., 1946.) [186

Board of Trade. Working Party Reports: Cotton. Pp. vi + 278. (London: H.M. Stationery Office, 1946.) 3*s*. 6*d*. net. [246

British Rubber Producers' Research Association. Publication No. 68: The Elasticity of a Network of Long-chain Molecules, 3. By L. R. G. Treloar. Pp. 12. Publication No. 69: The Statistical Length of Long-chain Molecules. By L. R. G. Treloar. Pp. 6. (London: British Rubber Producers' Research Association, 1946.) [256

Iron and Steel Institute. Report of Council for 1945. Pp. 14. (London: Iron and Steel Institute, 1946.) [256

Lister Institute of Preventive Medicine. Report of the Governing Body, 1946. Pp. 16. (London: Lister Institute, 1946.) [256

Ministry of Supply: Directorate of Royal Ordnance Factories (Explosives). Industrial Experimentation. By K. A. Brownlee. Pp. 116. (London: H.M. Stationery Office, 1946.) 2*s*. net. [266

Foreign Affairs and the Public. By John Price. (Looking Forward Pamphlets, No. 9.) Pp. 52. (London and New York: Royal Institute of International Affairs, 1946.) 1*s*. net. [266

Other Countries

Bulletin of the American Museum of Natural History. Vol. 86, Article 7: Temperature Tolerances in the American Alligator and their Bearing on the Habits, Evolution and Extinction of the Dinosaurs. By Edwin H. Colbert, Raymond B. Cowles and Charles M. Bogert. Pp. 327–374 + plates 36–41. (New York: American Museum of Natural History, 1946.) [116

American Philosophical Society. Year Book 1945, January 1, 1945–December 31, 1945. Pp. 440. (Philadelphia: American Philosophical Society, 1946.) [126

Mitteilungen der prähistorischen Kommission der Akademie der Wissenschaften. Band 3, Nr. 5–6: Funde der älteren und jüngeren Eisenzeit in Bludenz (Vorarlberg). Von Adolf Hild. Pp. 195–257 + 26 plates. 18R. marks. Band 4, Nr. 1–2: Bubanj, eine vorgeschichtliche Ansiedlung bei Niš. Von Adam Graf Orssich de Slavetich. Pp. 46 + 11 plates. 20 R. marks. Band 4, Nr. 3–4: Die frühbronzezeitliche Dorfanlage von Grosz-Mugl (Niederdonau). Von Eduard Beninger. Pp. 47–90 + 20 plates. 15 R. marks. Band 4, Nr. 5: Die junghallstattischen Grabhügel von Donnerskirchen (Niederdonau). Von Christian Pescheck. Pp. 91–106 + 5 plates. 4.50 R. marks. Band 4, Nr. 6: Der junghallstättische Grabhügel von Krensdorf (Niederdonau), von Josef Tomschik; Die junghallstättischen Grabhügelfunde von Krensdorf, Marz und Weiden am See (Niederdonau), von Christian Pescheck. Pp. 107–140 + 14 plates. 10 R. marks. Band 5, Nr. 1: Zu älteren metallzeitlichen Hügelgräberfunden aus dem Mühlharf, Kr. Fürstenfeldbruck/Oberbayern. Von Heinz Knöll. Pp. 36 + 6 plates. 6 R. marks. (Wien: Holder-Pichler-Tempsky A.G., 1939–1944.) [126

Proceedings of the United States National Museum. Vol. 96, No. 3198: Echiuroid Worms of the North Pacific Ocean. By Walter Kenrick Fisher. Pp. 215–292 + plates 20–37. Vol. 96, No. 3199: The Osteology of the Fossil Turtle *Testudo praeextans* Lambe, with Notes on other Species of *Testudo* from the Oligocene of Wyoming. By Charles W. Gilmore. Pp. 293–310 + plates 38–44. (Washington, D.C.: Government Printing Office, 1946.) [126

U.S. Department of Agriculture. Circular No. 745: Methyl Bromide as a Delousing Agent. By Randall Latta, Henry H. Richardson and James B. Kindler. Pp. 40. Circular No. 746: The Lily Weevil, a Potentially Serious Pest in the Pacific Northwest. By Charles F. Doucette and Randall Latta. Pp. 24. (Washington, D.C.: Government Printing Office, 1946.) [126

U.S. Department of Agriculture. Picture Sheet No. 13: Tomato Fruitworm. Pp. 2. (Washington, D.C.: Government Printing Office, 1941.) 5 cents. [126

U.S. Office of Education: Federal Security Agency. Bulletin 1945, No. 11: Report on the Cultural Missions of Mexico. By Guillermo Bonilla y Segura. Translated and edited in the American Republics Section, Division of International Educational Relations, U.S. Office of Education. Pp. x + 61. (Washington, D.C.: Government Printing Office, 1945.) 15 cents. [146

Indian Central Cotton Committee. Scientific Monograph No. 2: The Periodic Partial Failures of American Cottons in the Punjab, their Causes and Remedies. By R. H. Dastur. Pp. viii + 144 + 6 plates. (Bombay: Indian Central Cotton Committee, 1946.) 5.8 rupees. [146

Astronomische Abhandlungen der Hamburger Sternwarte in Bergedorf. Band 5, Nr. 2: Spektralphotometrische Untersuchungen von δ Cephei-Sternen. Von Adolf Günther. Pp. 19–32. Band 5, Nr. 3: Die Beobachtungen des Planeten 433 Eros während der Opposition 1930–31 auf der Hamburger Sternwarte in Bergedorf. Von R. Schorr, C. Vick und J. Larink. Pp. 33–84. Band 5, Nr. 4: Untersuchungen der offenen Sternhaufen NGC 7092 (M. 39), NGC 7209 und NGC 7243. Von Friedrich-Wilhelm Mävers. Pp. 85–104. (Hamburg-Bergedorf: Hamburger Sternwarte, 1939–1940.) [186

Jahresbericht der Hamburger Sternwarte in Bergedorf für das Jahr 1939. Erstattet von dem Direktor Dr. R. Schorr. Pp. 18 + 4 plates. Jahresbericht der Hamburger Sternwarte in Bergedorf für das Jahr 1940. Erstattet von dem Direktor Dr. R. Schorr. Pp. 14 + 2 plates. Jahresbericht der Hamburger Sternwarte in Bergedorf für das Jahr 1941. Erstattet von dem Direktor O. Heckmann. Pp. 16. Jahresbericht der Hamburger Sternwarte in Bergedorf für das Jahr 1942. Erstattet von dem Direktor O. Heckmann. Pp. 8. (Hamburg-Bergedorf: Hamburger Sternwarte, 1940–1943.) [186

Mitteilungen der Hamburger Sternwarte in Bergedorf. Band 8, Nr. 46: Bemerkung zur Dichteverleitung bei den δ Cephei-Veränderlichen. Von J. Hellerich. Pp. 12. Band 8, Nr. 47: Die Bestimmung der raumlichen Verteilung der Sterne als Ziel des Unternehmens der Bergedorfer Spektraldurchmusterung. Von A. Schwassmann. Pp. 13–32. Band 8, Nr. 48: Über die Beziehung zwischen den Amplituden der Licht- und Geschwindigkeitskurven bei den δ Cephei-Veränderlichen und verwandten Typen. Von J. Hellerich. Pp. 33–46. (Hamburg-Bergedorf: Hamburger Sternwarte, 1939–1940.) [186

Mitteilungen der Hamburger Sternwarte in Bergedorf. Band 8, Nr. 49, 50: Der Einfluss der atmospharischen Dispersion bei van Biesbroecks Bestimmung der Aberration eines aussergalaktischen Nebels, von O. Heckmann; Über die Aufstellung eines Generalkatalogs schwacher Sterne, von J. Larink. Pp. 47–56. Band 8, Nr. 51: Die Natur der Kometen. Von K. Würm. Pp. 57–92. Band 8, Nr. 52: Untersuchung der offenen Sternhaufen IC 4665, NGC 6633, IC 4756. Von E. Kopf. Pp. 93–106. Band 8, Nr. 53: Über einen neuen Nebelhaufen in Ursa major. Von A. A. Wachmann. Pp. 107–110. Band 8, Nr. 54, 55: Skizze eines neuen Spektralheliographen, von O. Heckmann; Das statistiche Gleichgewicht eines freien Systems von Massenpunkten, I, von O. Heckmann. Pp. 111–142. (Hamburg-Bergedorf: Hamburger Sternwarte, 1942–1944.) [186

Report of the Science Service, Dominion Department of Agriculture, for the Year ended March 31, 1945. Pp. 68. (Ottawa: King's Printer, 1946.) [206

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State of California: Department of Natural Resources, Division of Fish and Game, Bureau of Marine Fisheries. Fish Bulletin No. 63: The Commercial Fish Catch of California for the Years 1943 and 1944. By the Staff of the Bureau of Marine Fisheries. Pp. 84. (Terminal Island, Calif.: California State Fisheries Laboratory, 1946.) [256

Indian Forest Leaflet. No. 82: Fodder Trees in India. By M. V. Laurie. Pp. iv + 17. (Dehra Dun: Forest Research Institute, 1945.) 8 annas. [256

Bollettino Bibliografica: Médicine et chirurgie, véterinaire, chimie, pharmaceutique. No. 1. Pp. vi + 42. (Milano: Association Internationale de la Presse Medicale, 1946.) Yearly subscription, 300 lire, 2 dollars. [17

Food and Agriculture Organization of the United Nations. Report of the Special Meeting on Urgent Food Problems, Washington, D.C., May 20–27, 1946. Pp. viii + 39. (Washington, D.C.: Food and Agriculture Organization of the United Nations, 1946.) [17

Meddelanden från Göteborgs Musei, Zoologiska Avdelning. 86: Notes on the Hydroid *Campanulina panicula* G. O. Sars. By P. L. Kramp. Pp. 12. (Göteborg: Elanders Boktryckerei A.-B., 1941.) [17

Meddelelser om Grønland udgivne af Kommissionen for Videnskabelige Undersøgelser i Grønland. Bd. 80, Nr. 8: Siphonophora. (The Godthaab Expedition 1928.) By P. L. Kramp. Pp. 24. 1 kr. Bd. 80, Nr. 9: Ctenophora. (The Godthaab Expedition 1928.) By P. L. Kramp. Pp. 19. 1 kr. Bd. 80, Nr. 10: Pelagic Tunicata. (The Godthaab Expedition 1928.) By P. L. Kramp. Pp. 10. 0.50 kr. Bd. 81, Nr. 1: Medusae. (The Godthaab Expedition 1928.) By P. L. Kramp. Pp. 168. 8 kr. Bd. 121, Nr. 11: Hydroida. (The Zoology of East Greenland.) By P. L. Kramp. Pp. 52. 2.50 kr. Bd. 121, Nr. 12: Medusae, Siphonophora, and Ctenophora. (The Zoology of East Greenland.) By P. L. Kramp. Pp. 20. 1 kr. (København: C. A. Reitzels Forlag, 1942–1943.) [17

(*Continued from page iii of Supplement*)

DIRECTOR OF RESEARCH REQUIRED immediately for recently established research laboratory in London. Primary qualification a wide experience in bacteriology. Applicant should also have interest in, and some knowledge of, cognate subjects, especially chemistry. Adequate equipment and assistance are provided and duties will involve short- and long-term investigation in Bacteriological Department and the planning and direction of biochemistry and chemistry sections of the laboratory. Minimum salary £1,200. Pension scheme is in operation. Applications, with full details of qualifications, experience, age, and the names of three referees to whom confidential enquiries can be addressed, should be sent to Managing Director, Milton Antiseptic, Ltd., 12, Brewery Road, London, N.7.

APPLICATIONS ARE INVITED FOR THE post of Assistant in Anatomy (with medical qualifications) for Cape Town University. Some experience of teaching and working at anatomy and an interest in the scientific side of anatomy are essential, one who wishes to become an anatomist with a reasonable tenure of office. Salary scale £500 by £50 to £650 per annum, plus a temporary cost-of-living allowance, at present for a married man £75 per annum (and £12 per annum for each child under 18 years), for an unmarried officer £44 per annum.

Written applications (in duplicate, with copies of testimonials), giving date of birth, full details of qualifications and experience, and of posts held including dates, should be addressed to the Appointments Officer, Ministry of Labour and National Service, quoting reference No. F.A.1083 (from whom a memorandum giving the conditions of appointment is obtainable), by December 23. Only candidates selected for interview will be advised.

CHEMIST, AGE 25-35, DEGREE OR EQUIVALent, required by a London firm of Electrical Component Manufacturers. Industrial experience, preferably in the electrical industry, essential. Salary £400-£500 per annum, according to qualifications. Box 776, T. G. Scott & Son, Ltd., 9, Arundel Street, London, W.C.2.

METALLURGIST REQUIRED FOR LARGE oil refinery in the North West. Candidates must have first- or second-class honours degree (or equivalent) and aged not over 30. Sound knowledge of corrosion and alloy metals essential. Some previous industrial experience desirable, but not essential. Salary according to age, qualification, and experience, details of which please supply, also when available, to Box 765, T. G. Scott & Son, Ltd., 9, Arundel Street, London, W.C.2.

PAINT CHEMIST REQUIRED FOR LARGE oil laboratory in the London area. Must have good university degree. Age under 30. At least two years' experience with an industrial paint firm essential. Permanent position. Salary according to age, qualifications, and experience, details of which please supply, also when available, to Box 766, T. G. Scott & Son, Ltd., 9, Arundel Street, London, W.C.2.

CHEMISTS AND CHEMICAL ENGINEERS required for service at home and abroad with large petroleum organization. Vacancies exist for Research and Works Chemists. Previous industrial experience not essential, but candidates must possess first- or second-class honours degree, or equivalent, and be under 30 years of age. Salary according to age, qualifications, and experience, details of which please supply, also when available, to Box 767, T. G. Scott & Son, Ltd., 9, Arundel Street, London, W.C.2.

JUNIOR ASSISTANT PHYSICIST REQUIRED in the Biophysics Research Group of the Mount Vernon Hospital and Radium Institute, Northwood, Middlesex. Salary scale £350 by £25 to £400 per annum, with promotion to the Assistant Physicist scale after satisfactory service. Initial salary according to qualifications. Applications should be sent to the Secretary (from whom further particulars may be obtained) not later than December 28, 1946.

THE BRITISH BOOT, SHOE, AND ALLIED Trades Research Association, 30-36, Thorngate Street, Kettering, invite applications from research workers with appropriate qualifications to investigate problems concerning the relationship of footwear to health. Examples are: The effects of shoes on poise, gait, and orthopaedic functions; also the influence, in physiological aspect, of shoe materials and construction on comfort, perspiration, and ventilation. Salary according to qualifications and experience and on a scale comparable with that of the scientific civil service. Superannuation under F.S.S.U. Applications to the Director of Research.

RESEARCH CHEMIST REQUIRED FOR development work on inorganic fluorescent materials. Experienced worker preferred, accustomed to carrying out original investigations. Salary according to qualifications. Write, stating age and particulars of experience, to Personnel Manager, E. K. Cole, Ltd., Southend-on-Sea, Essex.

BIOLOGIST REQUIRED IN THE BIOphysics Research Group of the Mount Vernon Hospital and Radium Institute, Northwood, Middlesex, to undertake a study of the effect of radiations on dividing cells in vegetable and animal tissues. Salary up to £450 per annum, according to qualifications. Applications should be sent to the Secretary (from whom further particulars may be obtained) not later than December 28, 1946.

JUNIOR ASSISTANT PHYSICIST REQUIRED in the Clinical Physics Department of the Mount Vernon Hospital and Radium Institute, Northwood, Middlesex. Previous experience not essential. Salary scale £350 by £25 to £400 per annum. Applications to the Secretary, from whom further particulars may be obtained.

FIRM IN N.W. LONDON SPECIALIZING in the manufacture of industrial instruments and controls requires Assistants for its engineering and hydraulic laboratories. Candidates for either laboratory should have a degree in physics or engineering or equivalent qualification, and applicants for a position in the hydraulic laboratory should have sound knowledge of hydraulics and flow measurement. Applications, stating age, experience, and salary required, should be addressed to Box 775, T. G. Scott & Son, Ltd., 9, Arundel Street, London, W.C.2.

WANTED, RESOURCEFUL, INTELLIGENT man with degree in science or electrical engineering. Capable of research analysis and practical operation all aspects of cinematograph exhibiting business. Knowledge of operational research useful. Candidates should preferably be under forty years of age. Write, giving full particulars, to Box 784, T. G. Scott & Son, Ltd., 9, Arundel Street, London, W.C.2.

CHAMBERS'S ENCYCLOPAEDIA REQUIRE half-time or full-time services as Editorial Assistant of university graduate with an honours degree in physics and chemistry and some experience of editing scientific matter. Wide cultural interests are an advantage. Salary £350-£500 a year, according to the time given. Apply, stating qualifications, to Chambers's Encyclopaedia, Tower House, Southampton Street, Strand, W.C.2.

BRITISH SCHERING RESEARCH INSTItute, Brook Lane, Alderley Edge, Cheshire. The above institute requires an Organic Chemist of Ph.D. standard or equivalent having research experience in chemotherapeutics, preferably in the sterol field. A five-day week and pension scheme are in operation. Salary according to qualifications and experience. Full particulars and salary required to the Director of Research.

IT IS DESIRED TO SECURE THE FULL commercial development in the United Kingdom of British Patent No. 556837, which relates to Stereo-photofluorography, either by way of the grant of licences or otherwise on terms acceptable to the patentee. Interested parties desiring copies of the patent specifications should apply to Stevens, Langner, Parry, and Rollinson, 5 to 9, Quality Court, London, W.C.2.

A BACTERIOLOGICAL TECHNICIAN wanted for Biological Research Department, age 25-30. Applicants should state details of training and experience and give references. Salary according to qualifications and experience. Box 777, T. G. Scott & Son, Ltd., 9, Arundel Street, London, W.C.2.

MICROBIOLOGICAL CONTROL LABORAtory. Applications are invited from suitably qualified candidates (preferably graduates) to take charge of a microbiological control laboratory dealing with penicillin. Salary in accordance with qualifications and experience. Box 778, T. G. Scott & Son, Ltd., 9, Arundel Street, London, W.C.2.

REQUIRED, AN ASSISTANT LIBRARIAN for Scientific Research Laboratories in the London area. Knowledge of chemistry, French, and German essential. Library training or experience and typing desirable. Salary according to qualifications and experience. Apply Box 779, T. G. Scott & Son, Ltd., 9, Arundel Street, London, W.C.2.

ENGINEERING FIRM, GLASGOW, REquires Second-in-command for Research Department. High executive and technical ability; experience in modern flow theory and practice. Reply very fully, stating salary required, Box No. 326, 8, Serle Street, London, W.C.2.

PROOF READER AND GENERAL ASSIStant (man or woman) required on the staff of a technical journal. Some knowledge of physical, chemical, and engineering terms preferred. State age, education and experience, and salary required. Box 780, T. G. Scott & Son, Ltd., 9, Arundel Street, London, W.C.2.

PH.D., A.R.I.C. (WOMAN), FLUENT FIVE languages, seeks change of position. Librarian, abstracting, patents, editorial experience. Overseas post considered. Box P.230, T. G. Scott & Son, Ltd., 9, Arundel Street, London, W.C.2.

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