NATURE

No. 3937 SATURDAY, APRIL 14, 1945 Vol. 155

CONTENTS

Editorial and Publishing Offices
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.
Telephone Number : Whitehall 8831
Telegrams : Phusis Lesquare London
Advertisements should be addressed to
T. G. Scott & Son, Ltd., Talbot House, 9 Arundel Street, London, W.C.2
Telephone : Temple Bar 1942
The annual subscription rate is £4 10 0, payable in advance, Inland or Abroad.

WATER SUPPLY IN GREAT BRITAIN

LAST summer, the Government issued a White Paper on water policy in Great Britain, which was dealt with, in connexion with related current discussions, in *Nature* of August 5, 1944, p. 159. Since then, there have been frequent references to the subject in Parliament and elsewhere, showing that public opinion was alive to the many vital issues involved. Recently a committee of the Institution of Civil Engineers has produced a valuable "Report on the Government White Paper on a National Policy", and now the Government itself has brought before the House of Commons a Water Bill, where it was subjected to vigorous discussion.

The Bill follows closely the lines of policy indicated in the White Paper, though certain outstanding features are naturally clarified in some degree. On the administrative side, the major features are the vesting of all powers in the Minister of Health, including those which relate to surface waters as well as to underground supplies; coupled with a somewhat hesitating curtailment of the supposed right of the individual to do what he pleases with any underground water he can get. Regarding surface supplies, the intention, no doubt, is to accelerate and cheapen procedure by the substitution of local inquiry under more ordered regulations for the more costly and less fettered proceedings of parliamentary committees. Whether this aim will be accomplished may be in some doubt, in view of the fact that various bodies are given the right to object to the Minister's decision concerning the acquisition of lands and water-rights by water-undertakers, until those decisions have been ratified by Parliament.

A fundamental feature of the Bill is the important position of the Central Advisory Water Committee. The Committee is to advise the Minister (or any other Minister concerned) regarding the conservation and use of water ; to consider the operation of enactments which may affect water resources and to make representations thereon ; and to advise any Minister on questions relating to water which he may refer to it. Advisory powers could scarcely be drawn more widely. Unfortunately, however, the Bill gives not the slightest inkling of the constitution of this all-important body. The next clause states all too concisely that the Minister may, *by order*, make provision respecting its constitution and procedure. It is scarcely too much to say that on the constitution and working of this Committee the whole success or failure of the Bill will depend, and one might reasonably look for some guarantee that it will consist of men with the highest technical knowledge who will bring unfettered judgment to bear on problems referred to them. Through the work of this Committee the investigation of all problems of water supply in Great Britain should be organized, and the application of its conclusions to the conservation and development of water resources for all purposes should be ensured.

At the next stage, regional organization for the assessment of resources and the co-ordination of local schemes is to be promoted by the establishment of joint advisory water committees, in regions where the demand is judged to be large in proportion to local resources. This proposal is clearly to be viewed in connexion with the powers to define areas within which the right to abstract underground water is prohibited except by sanction of the Minister; for promoting voluntary or compulsory amalgamations of water undertakings; and for variation of areas of supply. In this case the general constitution, powers and duties of such joint committees are defined, and while it is reasonable (as laid down) that they shall consist mainly of representatives of the water-undertakings and local authorities concerned, it is to be regretted that there is no provision for independent scientific and technical advisers.

Further power of control is provided by clauses for the compulsory purchase of land, either for water-works or for the protection of supplies, and for the enforcement of by-laws designed to protect sources against pollution by any acts of the owners or occupiers of the land from which such supplies may be derived. In practice, this last will largely concern the protection of underground supplies, and will depend for effective application on very detailed geological knowledge to define the areas which the by-laws should control.

An examination of the Bill tends to confirm some of the doubts expressed by the expert committee appointed by the Institution of Civil Engineers in its report on the White Paper. All will agree with the committee's general commendation of the White Paper (which it would doubtless extend to the Bill) as representing a valuable step in the development of official recognition of the vital public importance of water questions. At the same time one feels that the committee has been cautiously reticent in the expression of its views, some of which would probably receive more forceful expression by the members as individuals. While modestly disclaiming its right to express an opinion on policy of a controversial nature, the committee evidently is in no doubt that the control of water should be in the hands of a single central authority, with the fullest scientific and engineering knowledge at its command, with power to formulate policy in the light of such knowledge, and to guide the development of water schemes accordingly. It is in this matter of clearly defined organization and control that the proposals of the White Paper (and the Bill) fail to show complete grip of the requirements, and betray too familiar concern for the susceptibilities of existing organizations.

Beyond this central conception, the valuable comments of the Institution's committee may be reduced almost to the single word—research. It is most stimulating to have so clear an expression, from a source of such authority, of the urgent need for more data and more study. Far more extensive records of rainfall are needed for Great Britain generally, and still more intensive studies of its wide variation within small regions. The great need for river-gauging on a well-organized plan is properly stressed; and one readily appreciates the committee's doubts whether any such scheme would be likely to develop properly under the proposed river boards. The whole fundamental question of percolation and its relation to the maintenance of underground supplies demands far more extensive investigation than it has yet received in Britain. It is not a matter for the mere application of general principles, but for close and prolonged investigation in representative areas. The importance of the general collection and tabulation of information regarding underground water is properly stressed by the committee, which also does well to direct attention to the fact that much of the most valuable information necessary for preparing maps of underground water-levels is provided by great numbers of private wells, a large proportion of which may soon be abandoned. Their investigation, especially in regard to their seasonal variation, is therefore the more urgent.

It appears likely that the committee would feel satisfied that its views regarding such matters as the assessment of compensation water and the protection of underground supplies are reasonably met by the Bill. In general, the proposals for the collection of data regarding underground sources may be adequate, though it is still far from clear that all the information is to reach a single centre for co-ordination and study. Details of new borings are to be made available to the Geological Survey (under guise of the Committee of the Privy Council for Scientific and Industrial Research), but what is to be the fate of all the information collected by the joint advisory water committees? More especially, what must impress all who have studied the Bill, is the absence of any clear provision for the investigation of surface waters and the problems associated with them, though such sources still provide much the larger part of the water supply of Great Britain. The White Paper indicated the need for extending the work of the Inland Water Survey—though it confused the issue by stating that the Survey's most vital work of river gauging should be undertaken by the river boards. In the Bill no such matter is specifically mentioned, and one is left to hope that this and many other things may be included under the Minister's general duty to promote "a national policy relating to water".

The last of the valuable proposals by the committee of the Institution of Civil Engineers is for the appointment of a research committee to co-ordinate work relating to water problems, as it may be conducted in various Government departments, in the universities or by water undertakings. Here, surely, should lie one of the most important functions of the Central Advisory Water Committee. If that committee is constituted of men of unquestioned independence, experience and knowledge, representing the various branches of administration, science and engineering involved, we shall have every reason to hope that the good intentions which undoubtedly lie behind the Bill will really be translated into practice. Here, if anywhere, we may find the 'single authority' which should be responsible for the water policy of Great Britain.

PROBLEMS OF THE LOCATION OF INDUSTRY

CRITICISM of the Distribution of Industry Bill in the House of Commons on March 21 appeared to centre essentially on two points, which found expression in the amendment moved by Sir George Schuster but afterwards withdrawn when the Minister of Production had made a statement: first, that no steps have been taken to establish a central independent tribunal to consider the national position as a whole, as recommended in the report of the Barlow Commission; and, secondly, that there has been no satisfactory implementation of the Government's intentions, as set forth in the White Paper on Employment Policy, that the Board of Trade should be suitably strengthened to undertake the new responsibilities proposed in the Bill. Sir George Schuster, in moving his amendment, made it clear that he only supported the Barlow Commission's recommendation for a central authority to review the position of the country as a whole and to make research into all those factors which affect the location of industry, in so far as such an authority stood outside the political field and was capable of an independent and objective review of the position, and of keeping it under constant survey. He did not advocate the establishment of an independent authority with large powers outside the control of Parliament, and in so far as Mr. Lyttleton accepted the view that a large conspectus was required, there may be no more difference between his position and Sir George Schuster's than between the majority and minority recommendations of the Barlow Report regarding the constitution and functions of the national authority.

That difference, however, was, in effect, as to whether the central planning authority or national industrial board should be a purely advisory body, or whether a separate executive department presided over by a Cabinet Minister should be created. The need for such an authority was not in dispute. It is the reluctance of the Government to implement the recommendation that it professes to accept which causes uneasiness, and Mr. Lyttleton's remarks about the impracticability of an independent authority appear to be little more than a quibble designed to cover indecision on the part of the Government. The question is essentially that of relating knowledge and action, and the fear that action may be determined by prejudice rather than knowledge underlies much of the criticism of the Distribution of Industry Bill.

There was little in Mr. Lyttleton's speech to indicate adequate appreciation that much research and collection of factual data are necessary as a foundation for an effective national policy. That was Sir George Schuster's main point. All areas of Britain require consideration as part of a national plan, since all are, in a sense, development areas in this time of immense technical and scientific advance. Proper surveys are required in all regions if we are to determine our broad objectives and first steps.

Apart from the surveys in the special areas, a good deal has already been done in regional surveys. Besides the surveys of West Cumberland and of South Wales for which Colonel W. C. Devereux has been responsible and to which Mr. Dalton also referred, Sir George Schuster mentioned work done by the West Midland Group in surveying the Midlands area, and a survey by a Thames-side group of industrialists. Even the more limited surveys, such as those on which the "Plan for Merseyside" is based, require linking to larger regional surveys of, for example, south Lancashire as a whole, and the failure to relate schemes such as the Tummel-Garry project or the Gairloch project prepared under the Hydroelectric Development (Scotland) Act of 1943 to an adequate national and regional planning scheme in which the location of industry is considered in relation to the utilization of national resources as a whole and not merely of water power is, to say the least, far from reassuring.

Besides these, the Northern Industrial Group, formed in 1943 to develop and promote the prosperity of existing industry generally, including the basic industries on which the north-east of England depends for the bulk of its employment, and to encourage commercial, technical and industrial research with the view of developing ancillaries to the basic industries and to attract and help to establish new industries, while sponsoring no formal surveys, has done something to elucidate the action required to prevent the recurrence of depressed areas. Its recently issued "Memorandum on the Government White Paper on Employment Policy", like its earlier memorandum, "Considerations Affecting Post-War Employment in the North-East", shows the extent to which industry itself is already prepared to advise and co-operate with the Government in respect of industrial needs and development in relation to local and national plans.

So far as the location of industry and the development of the north-east of England as a balanced unit are concerned, this latest memorandum urges that whatever administrative system is evolved by legislation in future must take all the relevant factors more carefully into account than has been done under the war-time controls. Besides urging the working out in greater detail of the application of 'negative licensing', the memorandum points out that, in framing a long-term policy, it is essential for the Government to make its decisions on policy now, so that industry may know how to plan for the future even if the date when plans can be put into effect must remain undecided. In particular, the memorandum calls for an early decision on the general policy for location of industry, transport facilities, etc. Immediate arrangements are required for more extensive factory construction in the north-east, including the reconversion of factories in the area from war to peace production, licences to build for firms who have chosen their own sites in the area, and information as to when these are likely to be granted, and the provision of adequate housing for operatives and administrative and technical staff. Existing responsibilities of the Commissioner for the

Special Areas should be transferred to the Board of Trade, and a single agency appointed to act on behalf of the Government in regard to existing or proposed Government factories or buildings; any regional organization established for dealing with the reconversion of industry should consist of Government representatives only, with full executive powers, but advised by a parallel group representing employers, employees and other interests in the area.

The Northern Industrial Group, and the more recently formed North-East Development Association, are clearly well qualified to advise in many ways any Government regional organization which may be established; but this evidence that industry is prepared and anxious to co-operate only gives greater force to the two critical conditions brought out in the recent House of Commons debate: an adequate central planning authority competent to make the broad policy decisions required, and a staff qualified to exercise the positive functions necessary to stimulate and not repress enterprise—and, it might be added, alert to check any restriction or restraint of trade masquerading under the title of development or any other catchword.

Sir George Schuster insisted on the need for some central authority to fit together the results of the regional surveys into a national survey, though he also stressed the need for liberty for all regions to develop within certain broad limits; both these points are widely enough held to represent a broad consensus of opinion. That consensus is scarcely recognized or accepted by the Government as yet, in spite of Mr. Dalton's claims that the Bill represents the largest common measure of agreement in the Government itself. The need is not met entirely by the Location Planning Room which has been transferred from the Ministry of Production to the Board of Trade as a joint responsibility of the two Departments. It is true that, as Mr. Lyttleton said, this valuable experiment will offer industry an information service regarding location which has never been available before, and that it will relieve industrialists of much of the burden of primary inquiries and thus facilitate decision. It is also in accord with a main recommendation in the Barlow Report. But it is equally clear from the debate that the operation and development of this planning room and all it stands for by the Board of Trade will be regarded with misgivings or scepticism by industrialists until there is evidence that the Board is being strengthened in the way that the White Paper on Employment Policy indicated.

Although Sir George Schuster pressed for central guidance, he also insisted on the need for a spirit of co-operation between industry and Government, with industry being given the information which would enable it to respond intelligently to the Government's policy and guidance. No two things would do more to secure that than evidence, first, that the Government has a central policy in regard to the location of industry, with all that is involved in the related problems of the control of land use, town and country planning, agriculture, and building, and secondly, that efforts were being made to equip the Board of Trade—and other departments—with the type of Civil servant qualified by training, outlook and experience to deal with these positive functions of government with imagination, decision and courage. By removing the fear of mere restrictionism, this second step would go far to remove the misgivings with which this first measure of control of location of industry has been received; but until the Government has offered some clear proof that it is willing and able to deal courageously and constructively with the central issues involved, no improvement in staffing of Government departments or co-operation on the part of industry will avail to avoid the wastage of national resources or the recrudescence of derelict areas in the years immediately ahead.

MODERN STATISTICAL METHODS IN INDUSTRY

Sampling Inspection Tables

Single and Double Sampling. By Harold F. Dodge and Harry G. Romig. Pp. vi+106. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1944.) 1.50 dollars.

Regression Analysis of Production Costs and Factory Operations

By Philip Lyle. Pp. xii+208. (Edinburgh and London: Oliver and Boyd, 1944.) 15*s*. net.

FOR about twenty years, statistical methods have been finding their way into the control of industrial processes. In the 1920's only slow progress was made against a great deal of doubt and opposition from manufacturers themselves. About 1932 the tide began to flow more strongly and increased in force as the modern methods were found to provide not merely a new way of formulating old knowledge but also a technique involving substantial saving in labour and money. The War itself has probably done more in six years than peace would have done in sixty to promote the widespread adoption of the new methods. In 1935 a few enthusiasts in Great Britain were still trying to persuade manufacturers of the power of the new tools at their disposal; in 1945 there is a division of the Ministry of Supply encouraging research in these tools and acting as the centre of an extensive network of quality control.

The volumes under review are interesting examples of the use of methods involving the theories of statistics and probability in two rather different branches of the industrial process. Mr. Dodge and Mr. Romig are concerned with economy in inspection of a mass-produced article and the guarantee of quality to the consumer. Mr. Lyle is concerned mainly with the dissection of costs in a manufacturing plant and their relation to output and utilization of production factors.

The four Dodge-Romig tables are prefaced by what are virtually reprints of articles in the *Bell System Technical Journal* in which they were originally published. The tables have been in general demand since the outbreak of war, and their issue under one cover will be welcome.

There are two main reasons why inspection on a sampling plan is necessary in certain types of industrial process. The first is that test-inspection may destroy the sample, as for example in dealing with ammunition, the only satisfactory way of testing a round being to fire it. Secondly, the sheer volume of production and expense of inspection may make it a physical or financial impossibility to examine more than a proportion of the output. Dodge and Romig are concerned mainly with the second class of case.

The so-called system of *single* sampling lays down a routine on the following lines : the product comes forward from the factory in aggregates known as 'lots'. A sample of specified size n is taken from each lot and examined. If it does not contain more than a specified number c of rejects, the lot is accepted in total. If it does contain more, the lot is completely inspected and rejects eliminated. The *double* sampling process is more elaborate. From any lot a first sample of n_1 is chosen. If the number of rejects does not exceed some level c_1 the lot is accepted. If it exceeds some number c_2, the lot is inspected in full. If it lies between c_1 and c_2 a second sample of n_2 pieces is taken and inspected. If the number of rejects in this second sample does not exceed c_2, the lot is accepted ; in the contrary case it is inspected in full.

In either process there is a possibility that lots will be passed which fail to fall below some specified tolerance level. The probability that this is so is the 'consumer's risk' of getting an unsatisfactory lot. In the single-sampling tables it is taken as 10 per cent. For any specified tolerance limit and consumer's risk it is possible to find what number c should be determined as the acceptance level with a given sample size n ; but either c or n is still at choice. Dodge and Romig determine those values which make the necessary number of inspections a minimum.

A further concept due to the authors is that of AOQL (or 'average outgoing quality limit'), that is to say, the average proportion defective in the material *after inspection and the replacement of rejects where inspection is carried out in full.* The single-sampling tables give this quantity and thus provide, for specified sizes of the lot, lot-tolerances, process averages (that is, population values of the proportion of rejects) and a consumer's risk of 10 per cent, the appropriate sample size n and the acceptance number c which will minimize the inspection required. The first of the double-sampling tables is on the same lines but of course specifies the two acceptance numbers c_1 and c_2. There are two further tables of a similar character based on specified 'average outgoing quality' limits instead of lot tolerances.

The computation of the tables was no easy task, even with the help of various approximations. The values given are no doubt sufficiently accurate for working purposes, but it seems possible that the methods employed of arriving at them are capable of improvement and refinement. The whole subject furnishes an interesting field for research in practical mathematics ; and in the meantime the Dodge-Romig tables continue to do first-class service to industry.

The most encouraging feature of Mr. Lyle's book is that it is written, not by a statistician, but by a practical industrialist who has proved the value of regression analysis in his own field. One of the better ways of learning statistical methods is to write a good book about them ; and that is what Mr. Lyle has done.

In many respects sugar refining is an excellent industry on which to test and to illustrate regression analysis. The final product, perhaps the purest known to commerce, has a standard which is easily measurable. Apart from molasses, there are no other end-products to complicate the allocation of costs. The factory operations are relatively simple, and Mr. Lyle has only to consider in his main analysis of operating costs the factors of labour, fuel and factory overheads (in which he includes maintenance and renewal of machinery). In fact, sugar refining can claim to be the hydrogen atom of industrial production, the simple model exhibiting the essentials of the theory with a minimum of complications.

Mr. Lyle considers in the first place a comparatively short period of forty weeks, and shows how to represent the weekly output as a linear function of the weekly cost and to test the significance of the results. He proceeds to more complicated cases by introducing further variates, including non-linear terms, and discusses the accuracy of the estimates in terms of fiducial limit bands (which for this purpose are identical with confidence intervals). He then deals with long-term changes in the production costs, has a few pages on price- and wage-levels, discusses unit costs and concludes with a number of appendixes on notation and the technique of correlation and regressive analysis. In effect, Mr. Lyle shows in a most illuminating way how the statistician can take up the inquiry into production costs at the point where the cost-accountant has to lay it down.

The book is not intended as a statistical text-book but as an introduction to such a book. Nevertheless, it provides one of the best exemplifications of a particular branch of theory I have seen. In feeling his way into the subject Mr. Lyle has encountered a number of practical difficulties, such as the effect of outliers on the regression line, which are apt to be glossed over in theoretical treatments. He has, quite rightly, dealt with them at some length and managed to achieve an excellent balance between theory and practice. It is to be hoped that he will be successful in his main object of "trying to interest industrial workers in a very useful subject of the very existence of which many of them are quite unaware".

M. G. KENDALL.

THE FLORA OF THE PACIFIC STATES OF AMERICA

Illustrated Flora of the Pacific States

Washington, Oregon and California. By Leroy Abrams. In 4 vols. Vol. 2 : Polygonaceae to Krameriaceae, Buckwheats to Kramerias. Pp. viii + 635. (Stanford University, Calif. : Stanford University Press ; London : Oxford University Press, 1944.) 45*s*. 6*d*. net.

THE region of the Pacific States with which the book under review deals is of great interest to the student of geographical distribution and the taxonomist. The area is peculiarly rich in endemic genera and species, and this is especially true of California. The Pacific States show interesting geographical connexions with the flora of Eastern Asia in genera, however, which are probably too recent in origin to be adduced in support of any hypothesis of continental drift, but are to be regarded rather as evidence of the similarity of ecological conditions and the high efficiency of dispersal agents, not perhaps excluding man himself. Thus the saxifragaceous species *Leptarrhena pyrolifolia* is native both to the coastal regions of north-west America and to eastern Asia. Again, the genus *Pectiantia* comprises five species of which three are endemic to the Pacific

States, whereas the other two are natives of Japan. But it is in the endemics of the region that the chief interest of the flora rests. Some of these, such as *Romneya Coulteri*, the genera *Eschscholtzia* and *Lewisia*, are familiar to British horticulturists. In the family Polygonaceæ the monotypic genera *Gilmania*, *Nemacaulis* and *Hollisteria* are all endemic to California while of the 150 known species of *Eriogonum* 80 are found in the Pacific States, many of them endemic. In the Crassulaceæ there are some 35 endemic species belonging to the genera *Sedella*, *Budleya*, *Stylophyllum*, *Hasseanthus* and *Gormania*. In the Cruciferæ most of the species of *Thelypodium*, *Streptanthus* and *Caulanthus* are endemic. The Rosaceæ, too, provide a large number of endemics, particularly in the genera *Horskelia* (19 spp.) and *Ivesia* (17 spp.). In the Leguminosæ the outstanding genera in this respect are *Lupinus*, of which 58 species are probably endemic, *Hosackia*, of which most of the 39 species are endemic, while *Astragalus* is represented by 137 species of which 83 are probably endemic.

It is obvious therefore that botanists generally will warmly welcome the appearance of the second volume of Prof. Abrams' monumental work. The first volume appeared in 1926 and dealt mainly with the vascular cryptogams and the monocotyledons. The present volume comprises the families belonging to the Polygonales, the Centrospermeæ, the Ranales, the Rhoedales and the Rosales and contains generic and specific keys, descriptions and illustrations of 1,663 species. The figures are in general good, but some of those reproduced from Britten and Brown's Flora might well have been replaced, such as those of *Dryas drummondii*, *Lychnis coronaria* and *Rumex pulcher*, where the characteristic appearance of the species had quite evaded the artist.

The plan of the Flora and the concept of species which is adopted is very similar to that in Britten and Brown's "Illustrated Flora of the North United States and Canada". It is therefore of some interest to compare the plant populations as presented in these two works. The richness of a flora in species is related on one hand to the size of the area concerned and on the other to the diversity of ecological conditions which it presents.

Britten and Brown's Flora treats of a vast area of some two million square miles, ranging from the Atlantic to the 102nd meridian and from south Virginia to the Arctic. The Pacific States, on the other hand, comprise an area of only 323,000 square miles, but include mountains rising to an elevation of more than 14,000 ft. and a southern limit that extends beyond the Tropic of Cancer. Moreover, the geology is very varied in character. It is therefore of interest to note that, even in the families with which the volume under review is concerned and which are mostly north temperate in their climatic requirements, the number of species is about 50 per cent larger than for the northern States and Canada. In the Rosaceæ alone does the Pacific State flora lag behind. In the Polygonaceæ and Leguminosæ, the Pacific States have more than double the number of species, while in the Saxifragaceæ, Papaveraceæ and Portulacaceæ there are three times as many.

All botanical libraries will no doubt wish to add this volume for its own sake, but their straitened finances will enhance appreciation of the public spirit of those through whose financial assistance it has been possible to place this work on sale at so low a price. E. J. SALISBURY.

RITUAL PROHIBITIONS IN PRIMITIVE SOCIETIES

Taboo

A Sociological Study. By Dr. Hutton Webster. Pp. xii+393. (Stanford University, Calif.: Stanford University Press; London: Oxford University Press, 1942.) 24*s*. net.

PROF. HUTTON WEBSTER is well known from his earlier books on "Primitive Secret Societies" and on "Rest Days". His new book, on "Taboo", collects together from ethnographical literature a mass of data concerning the ritual prohibitions found in what are commonly called 'primitive societies'. His aim, as stated by himself, is "to show how important a place taboos hold in the cultural evolution of mankind". The author's definition is as follows: "Taboos form a specific series of thou-shalt-nots. They are not to be confused (as in popular usage) with social conventions and regulations of a negative sort, conventions and regulations without an obvious utility. They are to be distinguished from restrictions resting on the vague notion of unluckiness which attaches to certain acts or things or times, restrictions found in the lower culture and, under the attenuated form of a survival, lingering among ourselves. More important still, there are innumerable prohibitions, both animistic and non-animistic in character, which must likewise be excluded from the conception of taboo if this is to possess any scientific validity and retain a place in ethnological theory. Taboos are prohibitions which, when violated, produce automatically in the offender a state of ritual disability —'taboo sickness'—only relieved, when relief is possible, by a ceremony of purification".

Prohibitions relating to the reproductive life, the relations of the sexes, death and the dead, strangers and strange phenomena, sacred persons and sacred things are dealt with in separate chapters and there are more general chapters on sin and ritual defilement, on the economic aspects of taboo and on its social aspects.

What anthropological science needs is a satisfactory general theory of taboo, or better still a theory of ritual prohibitions in general. Such a theory should enable us to understand not only the widespread existence of such prohibitions, but also the forms they take. Interesting as the present work may be as a collection of examples, it fails to make any contribution to anthropological or sociological theory. Prof. Webster regards taboos in general as arising from the fears and forebodings that beset "primitive man" in an "unfriendly world". The fears themselves "are often the product of a lively imagination and of an abysmal ignorance". Taboos "reflect", he says, "man's ignorance of his surroundings, whether natural or what we call supernatural. They are rooted in the fear of the unknown and the unknowable".

It is evident that the statement that taboos result from man's ignorance and fear does not provide any explanation. It does not, for example, give any reason for those ideas of ritual defilement or pollution which Prof. Webster himself regards as an essential characteristic of taboos.

Perhaps it is unjust to criticize the author for not doing what he does not set out to do. He has given us an extensive compilation of illustrative instances of taboos. The theoretical problem of the nature and function of these prohibitions remains just where it was. A. R. RADCLIFFE-BROWN.

RUBBERS AND THEIR CHARACTERISTICS: REAL AND IDEAL*

By Dr. L. R. G. TRELOAR
British Rubber Producers' Research Association

Chemical Structure of Rubbers

NATURAL rubber, extracted from latex by coagulation with acid, and afterwards washed and rolled, appears on the market as crepe or smoked sheet. Raw rubber, as these materials are called, is essentially a hydrocarbon $(C_5H_8)_n$ having the chemical structure shown in Fig. 1. It is a polymer of isoprene, the isoprene units being joined together in the form of a long chain. The actual length of the molecular chain, or *molecular weight*, of rubber has been the subject of much discussion, estimates obtained by different methods having ranged from about 1,000 to about 500,000; and it is only within the last few years that the question has been settled. The reliable measurements of Dr. G. Gee show that the mean molecular weight of a typical raw rubber is about 350,000, corresponding to a chain of about five thousand isoprene units.

This long-chain molecular structure accounts for the very high viscosity of rubber solutions in ordinary solvents like benzene. We imagine that the resistance to flow is due largely to the mutual interferences and loose entanglements between these very long molecules. However, raw rubber is ultimately completely soluble, and we conclude, therefore, that the molecules are not in any way chemically joined together.

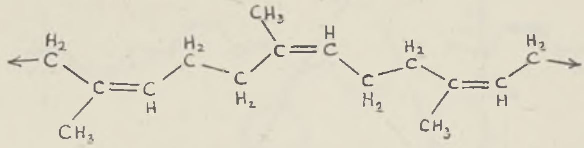
It is otherwise with vulcanized rubber, which swells considerably in solvents (to five or ten times its original size), as if it were trying to dissolve, and yet does not go into solution at all. In this case it is reasonable to suppose that the vulcanization (that is, chemical combination with sulphur) has led to a cross-linking of the molecules (see below).

Fig. 1 is intended to show the diversity of chemical composition of materials which, under certain conditions, show rubber-like elasticity. Whereas most practical rubbers are built up on a chain of carbon atoms, this is by no means an essential feature, as the examples of gelatin and elastic sulphur show. The important and invariable feature of all rubbers is the pattern of their molecular structure; there is no highly elastic material, so far as I am aware, which is not built up of very long chain-like molecules.

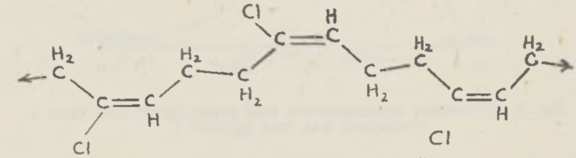
Origin of the Elasticity

Until about twelve years ago, none of the theories of the elasticity of rubber which had been proposed could be regarded as even approximately satisfactory. Attempts to interpret long-range elasticity on the basis of interatomic forces were manifestly inadequate, and it was not until Meyer, v. Susich and Valko introduced the conception of a *dynamic*, in contrast to a *static*, basis for the phenomenon that the mystery was solved. The theory developed rapidly through the work of Guth and Mark and of Kuhn, and is now generally accepted as representing the correct method of approach.

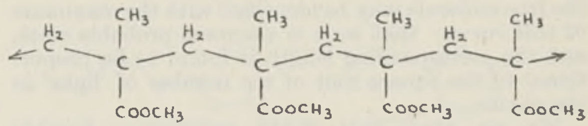
To understand the kinetic point of view we must first examine the form of a long-chain molecule, considered as an isolated unit. For this purpose it is usual to consider the simplest possible chain structure, namely, the paraffin molecule. The assumption is made that the carbon atoms of the chain are in a state of continual thermal vibration, so that they may take up any relative positions consistent with the maintenance of a fixed bond-length and a fixed angle between bonds ($109\frac{1}{2}°$). According to this assumption, each C—C bond may be regarded as rotating freely about the preceding bond as axis. There is chemical evidence that such rotation does take place. In consequence of this random rotation about bonds, the chain will not be a uniform zigzag in one plane, as in Fig 2*a*, but will assume a randomly kinked form in three dimensions, as indicated in Fig. 2*b*. The distance between the ends of the chain in this form is likely to be very much less than the outstretched length of the molecule in Fig. 2*a*, and the statistical treatment of the problem enables the probability of any given end-to-end distance to be calculated. The function representing this probability turns out to be the ordinary Gaussian error function,



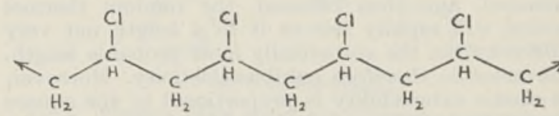
Natural rubber (polyisoprene).



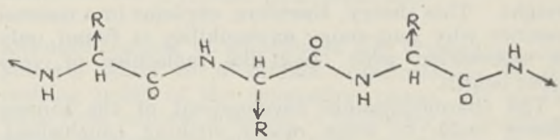
Polychloroprene ('neoprene').



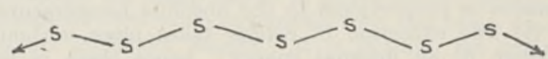
Polymethyl methacrylate ('perspex').



Polyvinyl chloride ('welvic').

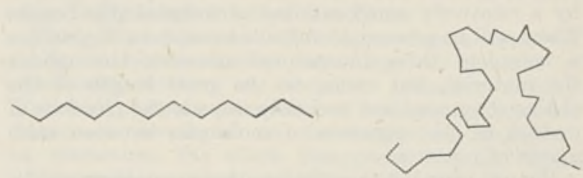


Protein (gelatin).



Elastic sulphur.

Fig. 1.



(*a*) (*b*)

Fig. 2. Paraffin chains: (*a*) planar zig-zag; (*b*) randomly kinked.

* Royal Institution discourse delivered on December 15.

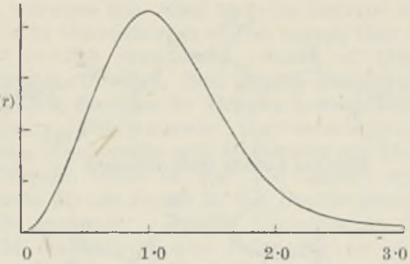


Fig. 3. FUNCTION REPRESENTING THE PROBABILITY $p(r)$ THAT A MOLECULE HAS THE LENGTH r.

which is represented in Fig. 3. The normal state of the free molecule may be identified with the maximum of this curve; that is, it is the most probable state, and the corresponding length is found to be proportional to the square root of the number of 'links' in the chain.

We see, then, that if the molecule is forcibly extended, and then released, the random thermal motion will rapidly restore it to a length not very different from the statistically most probable length. The molecule, therefore, exhibits elasticity. Moreover, its elastic extensibility is proportional to the square root of the number of chain links, or the molecular weight. This theory, therefore, explains in a natural manner why long-range extensibility is found only in association with chain-like molecules of very great length.

The thermodynamic development of the kinetic theory leads to some rather striking conclusions. Two of the more important of these are:

(a) In rubber held at constant extension, the tension is proportional to the absolute temperature.

(b) The extension of rubber takes place without change in its internal energy; hence there is an evolution of heat equal to the work done on the rubber by the stretching force.

In these two respects the behaviour of rubbers is closely analogous to that of a gas. The agreement with experiment which is found provides very strong evidence in favour of the theory.

The Ideal Rubber

Thus far our attention has been focused on the individual molecule. We have yet to consider in more detail how the elastic properties of the molecule are to be conveyed to the material in bulk. When we consider this problem, we see that in order to be able to take up a variety of statistical forms in the way required by the theory, the molecular chains must have a freedom of movement comparable with that in a liquid. On the other hand, for the rubber to maintain a permanent shape, and to resist applied stresses, the molecules must somehow be fixed in their *average* positions relatively to one another. To meet these two rather contradictory requirements it is necessary to think of the molecules as linked together by a relatively small number of unbreakable bonds. These will be present in sufficient numbers to produce a complete three-dimensional network throughout the material, but owing to the great length of the chains they need not seriously impede the freedom of motion of the segments of molecules between such points of junction.

We are thus led to postulate three necessary conditions for the occurrence of rubber-like elasticity, namely:

(1) The presence of long-chain molecules, with freely rotating links.

(2) Weak secondary forces around these molecules.

(3) A few points of cross-linkage, resulting in a loose 3-dimensional network.

The ideal rubber may be thought of as a permanent network of long-chain molecules held together by unbreakable bonds, but otherwise completely free to move. The stress-strain properties of such an ideal network have been worked out by a number of authors. The most satisfactory development in this direction is due to Wall (1942), who obtained the following equations for the case of a simple elongation (or uni-directional compression) and simple shear respectively:

For elongation,

$$F_a = NkT\left(\alpha - \frac{1}{\alpha^2}\right),$$

where F_a is stretching force, referred to original section of 1 cm.², N is number of 'molecules', a 'molecule' being the length of chain between its points of junction to the network, $\boldsymbol{k}$ is Boltzmann's constant, T is absolute temperature, and α is the ratio of stretched to unstretched length.

For simple shear,

$$F_\sigma = NkT\sigma,$$

where F_σ is shear stress and σ is amount of shear.

There are a number of particularly interesting features of these equations. First, the stress-strain curve for elongation is non-linear, that is, Hooke's Law does not apply, while for shear the relation is linear. Secondly, the only molecular property which enters into these equations is N, the number of chain elements in the network. This quantity is simply related to the 'molecular weight' of the chain. The precise constitution of the molecule or the number of freely rotating links which it contains is of no significance in this connexion. The third point, which is related to this, is that one physical constant only is sufficient to define the elastic properties of a highly elastic material.

I have extended the elastic network theory to the case of a deformation of any type, and shown experi-

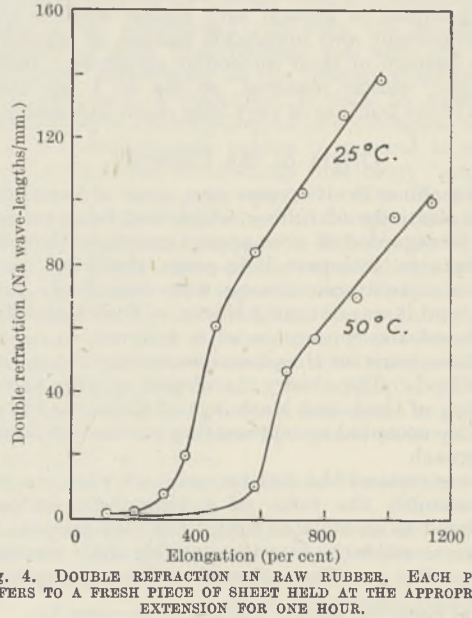


Fig. 4. DOUBLE REFRACTION IN RAW RUBBER. EACH POINT REFERS TO A FRESH PIECE OF SHEET HELD AT THE APPROPRIATE EXTENSION FOR ONE HOUR.

mentally that the resultant equations give a reasonably satisfactory account of the properties of well-vulcanized rubber under a number of different types of deformation, except under very high strains, when the underlying assumptions of the theory are no longer applicable.

Application to Real Materials

Having now defined the conditions under which rubber-like behaviour is to be expected, let us inquire to what extent real materials satisfy these conditions, and the way in which the non-fulfilment of these conditions leads to departures from the simple behaviour of the ideal rubber.

The first point of difference is that in practice rubber-like properties appear only within a certain range of temperature. At low temperatures rubbers are transformed to a glass-hard condition. Below the transition temperature the molecular chains become immobile, the thermal energy no longer being sufficient to overcome the secondary forces between the molecules. For a material like natural rubber, these secondary forces are relatively weak, and the transition temperature is very low (−70° C.). If the intermolecular forces are comparatively strong, the transition temperature is very much higher. This is exemplified by polymethylmethacrylate (Fig. 1), which is a glass at normal temperatures (being extensively used for its non-splintering property), but becomes highly elastic above about 70° C.

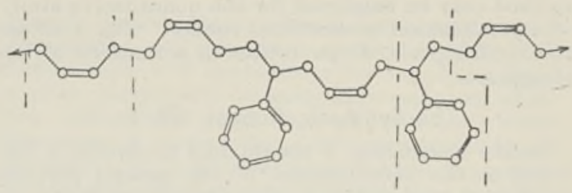
Rubber-like properties may also be lost at *high* temperatures, where, in the case of polymers which are not cross-linked, the molecules become sufficiently mobile to slide bodily past one another, the rubber thus becoming a viscous liquid. The longer the molecules, the higher the temperature at which this effect becomes noticeable.

This plastic property of rubber and the 'thermoplastics' is made use of in the processes of moulding, extrusion, etc. In the case of rubber the final form is 'fixed' by vulcanization—that is, combination with sulphur—which leads to a chemical cross-linking of the molecules.

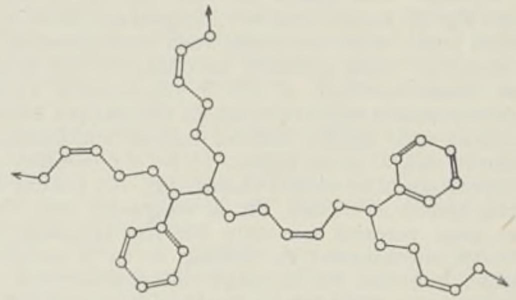
Crystallization

So far I have omitted one very important phenomenon which profoundly affects the mechanical behaviour of rubber, namely, crystallization. If raw rubber is held at temperatures below 0° C. for several days, it becomes comparatively hard and inelastic, and at the same time loses its transparency. This state is not to be confused with the glassy state, which occurs on quickly cooling to very much lower temperatures. The X-ray diffraction pattern of normal 'amorphous' rubber is like that of a liquid, there being only a single broad halo present. The same pattern is given in the glass-hard state. But the slowly frozen rubber shows a number of well-defined rings, which are to be interpreted as due to the presence of crystallites oriented at random, as in a powder.

Owing to the enormous length of the molecules, there are significant differences between the process of crystallization in rubber and in an ordinary low-molecular liquid. The crystallites are separated by regions of 'amorphous' or disordered molecules (crystallization is never complete), and, furthermore, a single molecule may pass alternately through several crystalline and amorphous regions. Thus the crystallites are bound together by amorphous rubber. This



butadiene (*a*) Straight chain. styrene



(*b*) Branched chain.

Fig. 5. POSSIBLE CHAIN FORMS FOR SYNTHETIC RUBBER GR—S (BUTADIENE-STYRENE POLYMER)

intimate binding of amorphous and crystalline components leads to a certain indefiniteness in the melting point of the crystalline phase, but at the same time imparts a degree of flexibility or toughness which is normally absent from crystalline bodies. The peculiar advantages of this type of molecular structure are made use of in polyethylene, which is chemically the same as paraffin wax, but has a much higher molecular weight. It is flexible, yet sufficiently hard for use as a cable-insulating material, and since the crystals hold the structure together vulcanization is unnecessary. The exceptionally valuable dielectric properties of the pure hydrocarbon are thus unimpaired.

Crystallization occurs not only in unstretched rubber at low temperatures, but also in stretched rubber at ordinary temperatures. By stretching, the molecules are brought into an approximately parallel arrangement, which greatly facilitates the crystallization process.

In stretched crystalline rubber the crystals all have one axis pointing in a fixed direction. Viewed by X-rays, this kind of arrangement gives rise to a series of spots arranged in a characteristic pattern. This pattern bears a rather strong resemblance to the X-ray pattern of natural fibres (cotton, wool, etc.), and in fact, stretched crystalline rubber behaves mechanically like a fibrous material, as Hock showed in 1924. If stretched crystalline rubber is frozen in liquid air and hammered, it splits along the fibre axis, just like a piece of wood. Also, it is very easily torn along the direction of the grain, but is, of course, exceedingly tough in other directions.

The rubber crystal is birefringent, hence stretched rubber is highly doubly refracting. If a piece of vulcanized rubber is stretched between crossed 'Polaroid' plates, a succession of brilliant interference colours is developed as the extension increases; on retraction, the effect disappears. If the same is done with unvulcanized rubber, the effect does not disappear entirely on removal of the tension; in this case the crystals are more permanent. The method may be employed for the quantitative study of crystallization in stretched rubber. Fig. 4 shows the birefringence of raw rubber as a function of the elongation.

The Synthetic Rubber GR–S

Before concluding, I should like to devote a few words to the consideration of the general purpose synthetic rubber GR–S now being produced in considerable quantities. This rubber, like the German 'Buna', is formed by polymerizing together butadiene and styrene. The chains are thus lacking in regularity (Fig. 5), since these two components occur in a random order, with the result that crystallization is not possible. This probably accounts for the much lower tensile strength of GR–S vulcanizates which do not contain a reinforcing agent like carbon black, compared with similar natural rubber vulcanizates. Moreover, there would appear to be a possibility of the formation of branched chains (Fig. 5*b*) leading to a cross-linked structure. It is suggested that this effect may account not only for the comparative difficulty encountered in milling it to a suitable softness, but also for its most unfortunate lack of self-adhesion. Self-adhesion involves a mutual diffusion at the surface of contact; any branching or cross-linking of the chains will considerably reduce such diffusion.

DIAGNOSIS OF MINERAL DEFICIENCIES IN CROP PLANTS*

By PROF. T. WALLACE
Long Ashton Research Station, Bristol

LIEBIG, in enunciating his mineral theory of the nutrition of crops in 1840, advanced the view that simple plant analysis would suffice to provide the data to determine the mineral requirements of crop plants and the amounts of mineral nutrients necessary to add to the soil to make good shortages due to removals by crops.

The field experiments of Lawes and Gilbert soon showed this conception to be erroneous and resulted in attention being focused on field trials and soil analysis as means of solving problems of crop nutrition, including deficiencies of mineral elements. From that time until 1920, these remained practically the only two methods in general use for determining deficiencies of mineral nutrients and the fertilizer needs of crops, and they still continue to play important parts in the solution of these problems.

Since 1920, however, other methods for diagnosing the mineral status of crop plants have been developed, based primarily on the plants themselves. In attacking problems in the field these methods are given complementary roles, and field trials and soil analysis are also included, with the result that problems are attacked from many angles and a choice of methods is available to suit the varied conditions which occur.

The new methods include visual diagnosis, foliage spraying, injection of leaves and stems, and chemical analysis of leaf laminæ and petioles and of stems.

In practice it has been found that none of the methods used alone will provide a complete solution of deficiency problems in all circumstances, but when used in complementary roles and with varied emphasis to suit different conditions, they have proved effective in solving very diverse and difficult problems.

* Summary of two lectures delivered at the Royal Institution on January 30 and February 6.

Visual Symptoms of Mineral Deficiencies*

The visual symptoms which result from mineral deficiencies in crop plants have proved a valuable aid in diagnosis and form the basis of the visual method discussed later. In view of the importance of this method to technical agriculturists, it was considered worth while to devote one lecture entirely to the subject of deficiency symptoms.

Although the symptoms produced are very varied they allow of some classification and grouping. Thus deficiencies of nitrogen, phosphorus, potassium and magnesium always affect older tissues first, and the visual signs progress systematically from the older to the younger parts of the plants, whereas the deficiency effects of calcium, iron and boron invariably appear first in meristematic tissues and often result in the death of growing points.

In field crops in Great Britain, deficiencies of all the essential elements, with the exception of sulphur, copper, zinc and molybdenum, have been recorded and frequently occur, and it is thus of interest to summarize some of the main features of the deficiency effects which have been observed.

The effects produced by nitrogen deficiency are very consistent over a wide range of plants. Growth is greatly reduced, stems are upright and thin, and lateral shoots are few, leaves are small and usually pale green in colour, flowering and fruiting are much reduced, and autumn tints of leaves, stems and fruits are usually brilliant, consisting of yellow, orange, red and purple colours. Defoliation is premature.

Phosphorus deficiency produces many effects similar to those resulting from nitrogen deficiency, but leaf symptoms are more variable. They may take the form of high colorations as for nitrogen deficiency; but more often the tints are dull shades of purple, or tints may be absent altogether, the leaves remaining a dull, lustreless, olive green, or the margins may become 'scorched'.

Potassium-deficient plants are generally squat in habit because of short stem internodes and, unlike deficiencies of nitrogen and phosphorus, lateral shoots may be abundant while shoots may die back. Marginal leaf scorch is a very common symptom, but leaves may also show tip scorch, chlorosis, spotting and backward or forward curling of the laminæ. Bright tints are often lacking, though not invariably so.

Calcium deficiency results in the death of the growing points of shoots, which condition may lead to the development of adventitious laterals, and in the distortion, wilting and scorching of leaf margins, collapse of petioles and the death of flowers. Root growth is much restricted and tuber formation seriously affected.

Magnesium deficiency is remarkable for the diversity of leaf effects produced. These include chlorosis, brilliant tinting with well-defined colour patterns, intervenal necrosis (both central and marginal) and spotting. The effects produced are often highly spectacular and ornamental. Defoliation is generally serious and may follow very quickly after the appearance of leaf symptoms. Deficiency effects usually develop at a relatively late stage of growth.

* For a full account and for illustrations of visual symptoms, see "The Diagnosis of Mineral Deficiencies in Plants by Visual Symptoms" (with 1944 Supplement) by T. Wallace. (H.M. Stationery Office.) 15*s*.

Iron deficiency is characterized by chlorosis of the foliage, which develops first on the young leaves at the tips of shoots and later spreads to the older foliage. As the veins often remain green the chlorotic pattern may take several forms, such as mottling or striping, according to the venation of the leaf.

The effects of manganese deficiency vary considerably. Many plants show leaf chlorosis similar to iron deficiency; but others, like oats and peas, develop symptoms unlike those produced by any other deficiency. Thus oats show lesions of the leaf tissues —grey speck—and peas lesions in the flat surfaces of the cotyledons—marsh spot.

Boron deficiency effects are notable both for their diversity and severity. They result from abnormalities in the development of meristematic tissues. The effects for individual crops are often so striking that many have been given descriptive names by growers, for example, heart rot of sugar beet, brown curd and hollow stem of cauliflower, cracked stem of celery and brown heart of swede. The injuries produced may affect growing points, epidermis, vascular tissues or pith.

Visual Diagnosis

In its simplest form, visual diagnosis consists of a comparison of plants growing under conditions of mineral deficiencies with suitable standards of deficient plants, usually in the form of photographic records and detailed descriptions. In practice, wherever possible, use is made of 'indicator' plants. These are plants which show characteristic effects for particular deficiencies and on which the deficiency symptoms are readily recognized. Examples of such plants are oats as an indicator plant for manganese deficiency, sugar beet for boron and potato for potassium.

Where indicator plants are present in instances of deficiencies in the field, particular deficiencies can usually be identified by mere inspection of the visual symptoms, but where this is not possible other methods must be used either wholly or in a confirmatory role.

Where the cropping potentiality of land is unknown, as has frequently occurred in the breaking up of new areas for arable cropping during the War, the visual method may be employed on special indicator plots. These plots combine indicator plants as crops sown in strips, crossed with a number of manurial dressings, which arrangement results in all the crops growing under conditions of the presence and absence of each of the particular elements likely to be deficient. This scheme has proved effective in solving a number of difficult problems.

The visual method cannot be applied in instances where symptoms are masked or prevented from developing by attacks of certain insect pests and fungus diseases and by certain other factors.

In applying the method, it is often useful to make observations on certain soil characters, for example, pH, texture and drainage, and in all doubtful diagnoses confirmation must be sought in the complementary methods.

Foliage Spraying and Plant Injection

These two methods both aim at introducing mineral nutrients into plants through stems and leaves, and they may be used as alternative procedures according to convenience of application.

Plants under experimental conditions may be supplied with their entire requirements of mineral nutrients, either major or trace elements, by means of foliage sprays, and in practice spraying is often more effective than soil applications for supplying trace elements, particularly for manganese and iron, which often cannot be given through the soil where deficiencies of these occur. Spraying methods are very simple. It is only necessary to know the correct strength of spray to use and the best time to spray. A watering can fitted with a rose is suitable for use on all ground crops, while for trees a pressure sprayer is required.

In practice, for trace elements the solutions used contain 1–2 oz. trace element compound per 5 gallon applied to 30 sq. yd. and for trees 3 lb. per 100 gallon is a suitable concentration; major elements are usually only applied to ground crops, at strengths of 1–2 lb. per 5 gallon. Where the foliage is difficult to wet it may be necessary to add a wetting agent.

Spraying is especially valuable for use with the visual method. Results are generally evident 5–10 days after treatment.

Both solids and solutions are used for injections, the former being useful only where woody stems are available for treatment. Solid injections are especially valuable for iron deficiency, as applications of iron salts to the soil are usually ineffective and sprays often damage the foliage. The technique of solid injections is based on the method originally evolved by Bennett[1].

Roach, at East Malling, has been responsible for the methods of liquid injection in use. The injections are made on laminæ and petioles of leaves and on stems, and methods have been developed for use on plants as widely different as cereals and trees[2]. The periods required for responses from liquid injections are similar to those for sprays.

With injection methods the time and dosage factors are again important.

Chemical Methods

In applying methods of chemical analysis to plants as a diagnostic procedure due regard is paid to established principles of plant physiology. The plant parts used comprise leaf laminæ, petioles and stems, as representing parts of the plants which reflect most accurately their mineral status. It is usual either to compare the status of mineral nutrients of healthy and unhealthy plants growing in close proximity or to make comparisons with standards fixed from previous experience. In this latter connexion it has been found possible, when sampling methods are standardized, to fix 'threshold' values for the various elements in particular plants below which deficiencies may be expected. The chemical data are generally computed on a basis of dry matter.

In selecting material for analysis, samples must be comparable from the physiological point of view, otherwise growth and seasonal cycles may render comparisons invalid.

During recent years, methods for carrying out rapid chemical tests on plant tissues, suitable for use either in the field or laboratory, have been introduced[3], which have proved useful in indicating deficiencies and in confirming the results of other methods.

The development of spectrographic and polarographic methods has also speeded up routine analytical procedures and made possible the detection of unusual elements giving rise to new problems.

A special technique for chemical diagnosis has been developed by Lagatu and Maume[4] in France and by

Thomas and Mack[5] in the United States, which has been designated 'foliar diagnosis'. The method compares the nutrient status of test plants with that of healthy, heavy-cropping plants, regard being paid to seasonal cycles of nutrients and to quantitative and qualitative aspects. The method is, of necessity, somewhat slow for general advisory purposes.

Chemical methods, however, are not infallible and if used alone may fail to provide the correct solution to certain problems. This is particularly so in instances of iron deficiency, where the element apparently becomes immobilized within the plant tissues from a variety of causes, as in lime-induced chlorosis, some instances of potassium deficiency and in the presence of toxic concentrations of other elements.

Soil Analysis and Field Trials

During the course of long usage, these methods have undergone considerable elaboration, soil analysis chiefly by the development of methods of determining 'available' nutrients[6] and by the introduction of rapid methods[7], and field trials by the development of designs allowing of statistical analysis[8].

The data provided by soil analyses can be of great value when used by an expert and supported by previous field experience, but they must be regarded only as pointers to probable mineral deficiencies since the intake of minerals by plants is not determined solely by chemical supplies in the soil. The method is chiefly of use for phosphorus and potassium deficiencies, and in providing data relating to acidity and organic matter.

As the response of the crop to a nutrient element, however the response may be obtained, must always be regarded as a final test of a deficiency of a particular element, field trials must always be of importance in diagnosis. But even here erroneous conclusions may be drawn, particularly so where trace element deficiencies may be remedied by changes in the pH of the soil. Thus, applications of sulphur to the soil may remedy a deficiency of manganese and alleviate deficiencies of iron and boron by lowering the pH, and conversely the application of lime may cure a deficiency of molybdenum. Moreover, soil dressings of manganese and iron salts are ineffective in many soils against these deficiencies, which nevertheless may be quickly and completely remedied by spraying or injection treatments.

The usual field trial methods may also be too slow in producing results for advisory purposes, as for example, for deficiencies of potassium and magnesium of fruit trees.

Experience with mineral deficiencies of crops in the field has shown that the problems may be very complicated and that no one method can be relied upon to provide a general solution. The most effective procedure is to use all available methods of attack in a complementary way, and in doing so, full use should be made of all the data which the plants themselves provide.

[1] Bennett, J. P., Univ. California Agric. Expt. Stat., Circ. 321 (1931).
[2] Roach, W. A., Imp. Bur. Hort. and Plant. Crops. Tech. Comm. 10 (1938).
[3] Thornton, S. F., Conner, S. D., and Fraser, R., Purdue Univ. Agric. Expt. Stat. Circ. 204 (Revised) (1939).
[4] Lagatu, H., and Maume, L., *Ann. l'école nationale d'agric.*, Montpelier, N.S., 22, 4, 257 (1924–33).
[5] Thomas, W., and Mack, W. B., Penn. State Coll. Bull. 378 (1939).
[6] Stewart, R., Imp. Bur. Soil Sci. Tech. Comm. 25 (1932).
[7] Morgan, M. F., Conn. Agric. Expt. Stat., Circular 127 (1939).
[8] Crowther, E. M., *J. Roy. Agric. Soc.*, 97 (1936).

OBITUARIES

Sir Hanns Vischer, C.M.G., C.B.E.

THE death on February 19 of Hanns Vischer has removed a notable and commanding figure from the sphere of African interests. Even his entry, more than forty years ago, into the political service of Northern Nigeria was in itself a notable event, for by birth he was a foreigner and his previous contact with Africa had been in the mission field; neither of which circumstances could in those early days be regarded as an 'open sesame' to the British Colonial Service. But there was that in Vischer's make-up before which all prejudice, British or African, melted like snow in the midday sun; and the reason was not far to seek. The Hausa people, quick at all times to detect the idiosyncrasies of their alien overlords, proclaimed the secret of his influence in two words. Throughout the country he was known as Dan Hausa ("Son of Hausa")—perhaps the most significant nickname ever conferred on a European in West Africa. It meant that in him the Hausas recognized, not only a man who possessed an extraordinary command of their delightful and expressive language, but also one whose affection for them was equalled by his insight into the innermost recesses of the African soul. It meant that they had, as it were, adopted him. One had only to watch him in his daily avocations in those early days to realize how completely at home he was with every class of society—whether he was engaged in grave deliberations with emirs, viziers and other high personages of the ruling hierarchy, or whether he was chaffing the hucksters at the market stalls as he rode through Kano city. No less revealing was it to see him in his own home pick up a native drum and, squatting on the floor, croon local Hausa songs to his own accompaniment. So inimitably did he do it that, if he had been hidden behind a screen, one would have said that an African musician had been engaged to entertain his guests.

No one who knew Kano in the years before the War of 1914–18 will ever forget the spirit of the motley community over which Hanns and Isabelle Vischer presided at the headquarters of the Education Department at Nassarawa. Isabelle's influence was second only to her husband's. If Hanns had it all his own way with the men, it was to Isabelle that the women laid bare their joys, their absurdities and their sorrows. She was the true *uwargida*, the mother, as Hanns was the father, of the great family.

It need scarcely be said how firmly Hanns and his wife were established in the affections of their British colleagues. Those—and they are now a much diminished band—who enjoyed their hospitality at Nassarawa before the War of 1914–18 will long remember the charm and gaiety of evenings spent in their company. Indeed, as one looks back, they, more than any two other people, seemed to embody the spirit that pervaded the Northern Nigeria Service in those early days—the light-heartedness, the good fellowship, the sport and, above all, the eager and adventurous interest in the problems of a fascinating and newly opened country.

Lack of space forbids me to speak of Hanns Vischer's later career, of his military service in the War of 1914–18 and of the widespread influence which he exercised as secretary of the Advisory Committee on Education at the Colonial Office and as secretary-general of the International Institute of African Languages and Cultures. In these larger spheres his great achievements have been widely known and acclaimed. If I have dwelt on the remote and less well-known period of his life in Northern Nigeria, it is because at that time the foundations of his future influence were laid—an influence which sprang from his passionate devotion to the people of Africa and the reciprocal devotion to him of the Africans whom he served so well. G. J. F. TOMLINSON.

Mr. Thomas Sheppard

WITH the passing of Mr. Thomas Sheppard at his home in Hull on February 18, the city has lost a notable character. Though officially the director of the Hull Museums for forty years (until his retirement in 1941), his activities ranged over a wide field, from organizing exhibitions directing attention to Hull's trade and commerce, and lecturing up and down the country on a variety of subjects, to contributing numerous articles to the Press.

As showing his diversity of interests, Sheppard was a past president of the Museums Association; the Yorkshire Geological Society; Hull Scientific and Field Naturalists' Club; Hull Geological Society; Hull Literary Club; Yorkshire Numismatic Society; Hull Publicity Club; Hull Luncheon Club, and the Hull Playgoers' Society; and a past chairman of the Conference of Delegates of Corresponding Societies of the British Association. He was also a member of the Hull University College Historical Committee, Hull Development Committee, and the Yorkshire Roman Antiquities Committee, and was local secretary when the British Association visited Hull in 1922. He issued two hundred Publications of the Hull Museums, edited the *Naturalist* for thirty years and was also responsible for the bibliographies of Yorkshire geology, and Mortimer's "Forty Years Researches".

Perhaps Sheppard's most important work was in connexion with geology, and he received the Lyell Award of the Geological Society of London for his contributions to this subject. In recognition of his scientific work, he received the honorary degree of master of science from the University of Leeds and he was made an associate of the Linnean Society.

During his long service as director of the museums of Hull, the Albion Street Museum, Wilberforce House, the Natural History Museum, Museum of Fisheries and Shipping, the Museum of Commerce and Transport, Mortimer Museum of Prehistoric Archæology, and the Railway Museum at Paragon Station were opened. In fact, he gained a well-known reputation of having very few scruples when it came to obtaining exhibits for his beloved museums.

A man of genial personality and a great sense of humour, he had been in failing health for some years, and the fact that his work was done, and the results of so many years of interest destroyed during the air raids on the city of Hull, contributed greatly to his death at the age of sixty-eight. J. B. FAY.

Dr. E. C. Wiersma

ACCORDING to a brief announcement in *Die Chemie* of October 28, 1944, Dr. E. C. Wiersma died at Delft at the age of forty-two. He was known for his work at the Kamerlingh Onnes Low Temperature Research Laboratories at Leyden. Both independently and in collaboration with Dr. W. J. de Haas, Wiersma had published a number of papers on the influence of low temperatures on the paramagnetism of certain metals and salts. He studied the adiabatic cooling of magnetic bodies and the production of low temperatures by adiabatic demagnetization. In 1931 he published a classification of para-magnetic atoms, molecules and ions based upon their fields at low temperatures. He also deduced a thermodynamic scale for temperatures below 1° Abs.

WE regret to announce the following deaths:

Sir James Barrett, K.B.E., C.M.G., sometime vice-chancellor and later chancellor of the University of Melbourne, and a founder and original fellow of the Royal Australian College of Surgeons, aged eighty-three.

Engineer Vice-Admiral Sir George Goodwin, K.C.B., formerly engineer-in-chief of the Fleet and a past-president of the Institute of Metals and of the Institute of Marine Engineers, on April 2, aged eighty-two.

Dr. G. L. Taylor, of the Galton Laboratory Serum Unit, recently seconded to the Medical Research Council, aged forty-seven.

NEWS and VIEWS

Bessemer Gold Medal: Award to Mr. Harold Wright

MR. HAROLD WRIGHT, chief metallurgist to Dorman Long and Co., Ltd., Middlesbrough, has been awarded the Bessemer Gold Medal by the Iron and Steel Institute in recognition of his "valuable contributions made over many years to improve the technique of iron and steel manufacture". The Medal, which is the highest award conferred by the Institute, will be presented to Mr. Wright by the president, Mr. Arthur Dorman, at the annual meeting of the Iron and Steel Institute in London on May 9. Mr. Harold Wright has been a member of the Institute since 1902 and has served on its Council; he is a past president of the Cleveland Scientific and Technical Institution and of the Cleveland Institution of Engineers. He started work at the North Eastern Steel Works. While with Sir Bernard Samuelson, Mr. Wright took an active part in the supply of molten basic iron to Dorman Long's Britannia Works when the latter firm introduced the hot metal process forty years ago. While in charge of the Newport coke ovens, Mr. Wright promoted the use of coke oven gas for town purposes. He first made the suggestion in 1902, but it was 1913 when the supply was first established. Mr. Harold Wright also possesses considerable geological knowledge, and has done a great deal of exploration work in connexion with the Cleveland ironstone deposits. He was also responsible for the introduction into local blast furnace practice of the use of rich foreign ores in the Cleveland burden. Mr. Harold Wright was appointed chief metallurgist to Dorman Long and Co., Ltd., in 1918. Last December the Company inaugurated a triennial Harold Wright Lecture to be given before the Cleveland Scientific and Technical Institution in recognition of his long and valuable service.

Dr. F. C. Steward

DR. F. C. STEWARD, reader in plant physiology in Birkbeck College, University of London, has recently left for the United States to take up a temporary appointment as research associate in the University of Chicago, where he is to develop certain aspects of plant physiology and biochemistry in which Prof. E. J. Kraus and the Chicago Department of Botany are interested. Dr. Steward has been given leave of absence by Birkbeck College for this purpose, and the appointment is a sequel to the destruction in an air raid of the research laboratory in plant physiology at Birkbeck, which had been largely equipped by the Rockefeller Foundation. Dr. Steward has been engaged since 1941 with the Ministry of Aircraft Production, where he developed a department dealing with statistics concerning the determination and forecasting of Royal Air Force requirements. It seemed that his return to botanical research would be delayed indefinitely by the destruction of his laboratory, so that the offer of Prof. Kraus has rendered a real service to botanical inquiry.

Mrs. Neville-Rolfe, O.B.E.

MRS. NEVILLE-ROLFE has resigned her office as honorary secretary of the British Social Hygiene Council. Fortunately this does not mean a severance of her interest in the Council. She has been elected a vice-president, and has also accepted a new office of honorary adviser, which will enable her to place at its disposal her great store of accumulated knowledge and experience. As honorary secretary of the National Council for Combating Venereal Disease from its foundation thirty years ago, she took the principal part in organizing the whole scheme of popular education in this subject—one hitherto taboo. In these early days the work of popular enlightenment on venereal disease was financed by a direct grant from the Exchequer; but the difficulty lay in persuading local authorities to avail themselves of the educational material offered by the Council, and in overcoming the resistance of many hospital authorities to the establishment of free clinics. In this work, and also in the organization of lectures to the armed forces during the War of 1914–18, Mrs. Neville-Rolfe was indefatigable.

As the years passed, it became increasingly obvious that the problem of venereal disease was only one aspect of a larger one, that of social hygiene in its wide sense, and that the Council's work should cover this wider field so as to combat the causes leading to sexual misconduct—the absence of biological teaching of the adolescent, the lack of training of teachers and instruction of parents, and the need for amelioration of various relevant social malconditions. At the same time, the name was changed to British Social Hygiene Council, and Mrs. Neville-Rolfe organized the wider field with undiminished zeal. In addition, however, to this work on the home front, she was able to extend its scope to the Dominions and the Colonies, in many of which branches and colleague organizations were established. Through the collaboration of the Government Departments concerned, several overseas visits and commissions were arranged and carried out by the Council between the years 1920 and 1936. Mrs. Neville-Rolfe, in 1926, spent six months in India, touring many provinces and States on the invitation of their respective Governments. She also, at various times, visited Canada, the Far East, Palestine, Cyprus, Jamaica and Southern Rhodesia, investigating local conditions and organizing measures for reducing the incidence of venereal disease. Liaison was also established internationally with the various foreign societies working in this field, and she was one of the founders of the Union Internationale Contre le Péril Vénérien, holding office as vice-president, and chairman of its Ports Commission. In 1941, she was awarded the Snow Gold Medal of the American Social Hygiene Council for work in social hygiene (*Nature*, **147**, 261; 1941).

Chemical Technology at Imperial College

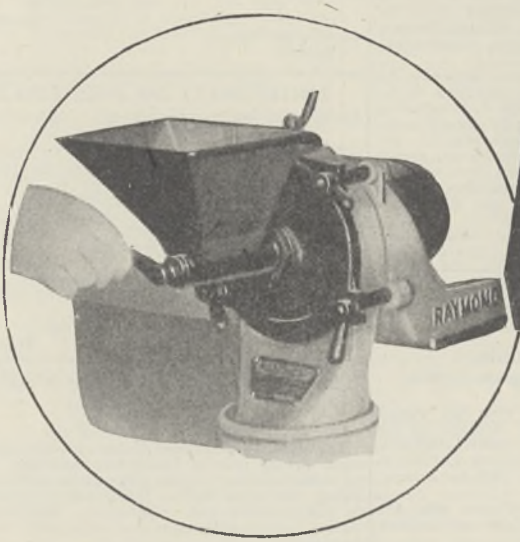
THE Imperial College of Science and Technology, with the approval of the Court of the University of London, has lately accepted from Messrs. Courtaulds, Ltd., a benefaction intended to promote its work in the field of chemical technology. This benefaction, which is calculated to yield an income of £3,000 per annum in perpetuity, will be administered for the present by a small body of trustees, and will permit the institution in Imperial College of a Courtaulds chair of chemical engineering, to which it is expected that an appointment will be made this year. It will also provide for other needs in the Department of Chemical Technology, in ways that will be decided by the trustees after consultation with the College. The Governing Body of Imperial College has recorded their most grateful appreciation of the gift, which is an outstanding event of this centenary year.

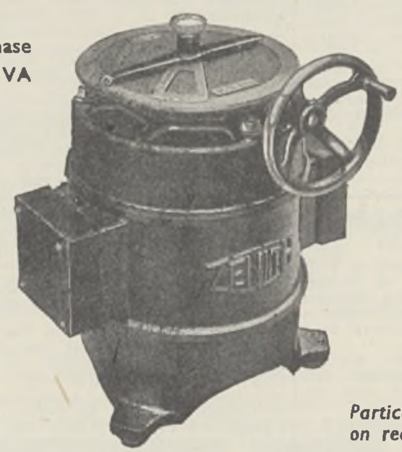
Visits of French and Belgian Medical and Scientific Workers

A FRENCH medical delegation of ten is visiting Great Britain during April 7–17 as guests of the British Council, in conjunction with the Royal College of Physicians, and will be entertained by other organizations, including the Royal Society of Medicine. The delegation will see hospitals in London and elsewhere and visit Oxford and Cambridge. The members are: Académie de Médecine: Prof. Baudouin, dean of the Faculty of Medicine, Paris, Prof. A. Lemierre and Dr. P. F. Armand-Delille; Conseil Supérieur de Médecine: Dr. Ravina, Dr. A. Laporte and Dr. H. Descomps; Provinces: Prof. C. Soula (Toulouse), Prof. Gernez-Rieux (Lille), Prof. Roche (Marseilles) and Dr. Nedelec (Angers). The first of four groups of representatives from Belgian universities, whose visits are being arranged by the Belgian Fondation Universitaire, will be in Britain during April 16–30. The other groups will follow at intervals between May and July. The members of the first group are: Prof. V. Bohet, professor of English, Liège; Prof. N. Goormachtigh, Faculty of Medicine, Ghent; Prof. P. Govaerts, Faculty of Medicine, Brussels; Prof. M. F. L. Hemptinne, Faculty of Science, Louvain; Prof. C. J. Jungers, Faculty of Science, Louvain.

Bibliography of the British Flora

WITH the view of eventual publication, it is proposed to compile a bibliography of the British Flora. One section of this, on local botany, would comprise all publications, which it is possible to trace, dealing wholly or partly with the flora of any area within the British Isles. This section would include local floras and works on topographical botany, and all publications, such as local and county histories, guide books, periodicals and newspapers, etc., in which plant lists of particular areas have appeared; manu-





The vacancies advertised in these columns are available only to applicants to whom the Employment of Women (Control of Engagement) Orders, 1942-8, do not apply.

The Royal Institute of Chemistry of Great Britain & Ireland

(Founded 1877)
(Incorporated by Royal Charter, 1885)

APPOINTMENTS REGISTER

A Register of Chemists (Fellows, Associates and Senior Registered Students), who are available for appointments or who are seeking to improve their positions, is kept at the office of the Institute. The facilities afforded by this Register are available (free) to Companies and Firms requiring the services of chemists, and to Universities, Colleges and Technical Schools requiring Teachers of Chemistry and Technology.

Particulars of the Regulations and Examinations of the Institute can be obtained (free), on application to The Registrar, the Royal Institute of Chemistry, 30 Russell Square, London, W.C.1.

BEIT MEMORIAL FELLOWSHIPS FOR MEDICAL RESEARCH

NOTICE is hereby given that an ELECTION of JUNIOR FELLOWS to begin work on October 1 will take place in July, 1945. Junior Fellowships are normally of the annual value of £400 for three years; but candidates, younger than those usually elected or whose promise for medical research must be judged mainly on work outside that field, may be awarded a lower rate of £300 for the first two years. Candidates are asked to state whether they would be unable to accept this lower initial rate.

Candidates must have taken a Degree in a Faculty of a University in the British Empire or a Medical Diploma registrable in the United Kingdom. Elections to Junior Fellowships are rarely made above the age of thirty-five years.

The Trustees are desirous of furthering research in Mental diseases and in the general allotment of Fellowships will give some preference to a candidate proposing research on approved lines in that subject.

Applications from candidates should be received by May 14, though late entries will be accepted up to June 1.

Owing to the disturbances caused by the War, it is necessary for candidates to submit evidence that they could be given accommodation in the departments where they propose to work.

Forms of application and all information may be obtained by letter only addressed to:

Dr. A. N. Drury, F.R.S.,
Secretary,
Beit Memorial Fellowships for Medical Research,
The Lister Institute,
Chelsea Bridge Road, London, S.W.1.

VETERINARY EDUCATIONAL TRUST

ELECTION TO A WELLCOME RESEARCH FELLOWSHIP

Applications are invited for the appointment to the above Fellowship from any person who on October 1, 1945 is under 36 years of age and has taken the Membership Diploma of the Royal College of Veterinary Surgeons or a degree in any Faculty in any University in the British Empire; or who, if a female, has passed an examination which would have entitled her if a male to take any such Degree.

The Fellowship, to the value of £450 per annum (liable to Income Tax) is tenable for one year and for a subsequent period of two years at the discretion of the Advisory Committee. The basis of annual remuneration may be increased under special circumstances. The Election will be made in June to take effect as from October 1, 1945.

Applications must be received on or before May 14, 1945.

Forms of application are obtainable from Dr. W. R. Wooldridge, M.Sc., M.R.C.V.S., Honorary Secretary, Wellcome Research Fellowships for Veterinary Research, 40 Westminster Palace Gardens, Westminster, London, S.W.1.

MANCHESTER ROYAL INFIRMARY

TECHNICAL ASSISTANT FOR CLINICAL LABORATORY WORK
(Non-resident, female.)

The Board of Management of the Manchester Royal Infirmary invite applications for the above post.

Applicants should hold a degree in science, or should have had special training in scientific methods of a nature which will qualify them for the work. The duties of the post require attendance daily (Sundays excepted) from 9 a.m. to 5 p.m., Saturdays to 1 p.m., working under the direction of the Director of the Clinical Laboratory. The work comprises routine examinations of blood, basal metabolism, etc.

The appointment is for one year, renewable for a further period subject to the provision of the Bye-Laws as to notice, etc., with a commencing salary of £200 per annum rising by annual increments of £25 to £300 per annum plus 8/- per week War Bonus. The selected applicants should be prepared to stay for at least two years if satisfactory. Federated Superannuation Scheme in force. Applications (stating age) with testimonials to be sent to the undersigned.

F. J. CABLE,
General Superintendent.

LONDON (ROYAL FREE HOSPITAL) SCHOOL OF MEDICINE FOR WOMEN

(UNIVERSITY OF LONDON)
8 Hunter Street, Brunswick Square, London, W.C.1.

Applications are invited from men and women holding degrees in Physiology or Medicine for the post of DEMONSTRATOR IN THE PHYSIOLOGY DEPARTMENT, from October 1, 1945, at an initial salary of not less than £300 per annum with superannuation benefits.

Further particulars may be obtained from the Warden and Secretary, to whom applications should be sent by May 19, 1945.

ROYAL HOLLOWAY COLLEGE

(University of London)
APPOINTMENT OF A SENIOR LECTURER IN APPLIED MATHEMATICS

The Governors invite applications for the above post, which is resident and open to women only. Applications are required not later than May 8, 1945. Full particulars may be obtained from the Principal, Royal Holloway College, Englefield Green, Surrey.

BRIGHTON TECHNICAL COLLEGE

Principal: Gordon E. Watts, M.A., Ph.D., B.Sc., F.R.I.C.

Applications are invited for the appointment of a Lecturer in Mathematics in the above college.

Salary according to Burnham Technical Scale, with allowances for approved industrial, research, and teaching experience.

Further particulars and forms of application may be obtained from the undersigned, and should be returned, with copies of at least two recent testimonials, by Monday, April 30, 1945, to the Principal of the College.

F. HERBERT TOYNE,
Education Officer.
54 Old Steine, Brighton, 1.

DERBY TECHNICAL COLLEGE

NORMANTON ROAD, DERBY

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

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

W. ALFRED RICHARDSON,
Principal.

ROYAL HOLLOWAY COLLEGE

(University of London)
Appointment of a Lecturer in Zoology

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

THE WEST OF SCOTLAND AGRICULTURAL COLLEGE

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

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

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

A. J. WILSON,
Secretary.
Blythswood Square,
Glasgow.

UNIVERSITY OF SHEFFIELD

Lecturer in Refractories in the Department of Metallurgy.

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

A. W. CHAPMAN,
Registrar.

BEDFORD COLLEGE FOR WOMEN

(University of London)
Regent's Park, N.W.1.

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

BEDFORD COLLEGE FOR WOMEN

(University of London)
Regent's Park, N.W.1.

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

BEDALES SCHOOL, PETERSFIELD HANTS

(Co-educational Boarding.)

Biology Mistress required temporarily, for Summer Term only. S.C. and H.S.C. Ministry of Education Superannuation. Salary according to experience and qualifications. Applications and testimonials to: F. A. Meier, Headmaster.

EMPIRE COTTON GROWING CORPORATION

Appointment of Assistant Secretary.

The Corporation invite applications for the post of ASSISTANT SECRETARY (male). A Degree in Agriculture or Botany is a necessary qualification, with some experience of administration. Age 25-30. Initial salary £550-£650, according to qualifications with superannuation arrangements similar to the F.S.S.U.—Particulars from The Secretary, Empire Cotton Growing Corporation, 37 Inner Park Road, Wimbledon, S.W.19.

HOME OFFICE FORENSIC SCIENCE LABORATORIES

Applications are invited for the post of Scientific Officer (Chemist) at the West Midlands Forensic Science Laboratory at Birmingham. Only well-qualified MALE candidates of British parentage should apply; a 1st-Class Hons. Degree in Chemistry and a Fellowship of the Royal Institute of Chemistry with the E. Certificate would be regarded as special qualifications. The salary would be in the range of £275-£650, according to age and qualifications.

Only a temporary appointment can be offered in wartime, but after the war the successful candidate would be considered for appointment to a permanent post on an incremental scale.

Write, quoting F.3859A, to Ministry of Labour and National Service, Central (T. & S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2, for application form, which must be returned completed by April 30, 1945.

UNIVERSITY OF LONDON

The Senate invite applications for the University Chair of Psychology tenable at Bedford College (salary £1,150). Applications must be received not later than first post on May 28, 1945, by the Academic Registrar, University of London, Richmond College, Surrey, from whom further particulars should be obtained.

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

Goodlass Wall and Lead Industries, Limited, invite applications by graduate metallurgists and chemists for immediate or post-war appointments for research work in their Metallurgical Research Laboratory at Perivale, Middlesex. The work is concerned with the smelting, refining and uses of Lead, Antimony, Tin and their alloys. Preference will be given to applicants who have carried out post-graduate research or who have had industrial experience in the production or working of Non-Ferrous Metals. Applications, which will be treated in strict confidence, should state age, availability, and give full details of qualifications and experience, and should be addressed to The Technical Director, Goodlass Wall and Lead Industries, Ltd., 17 Waterloo Place, London, S.W.1.

Applications are invited for the post of SUPERINTENDENT in a Government establishment. The Salary will be at a fixed rate within the range of £1,050-£1,200 per annum, according to qualifications and experience. Candidates should be well qualified in Chemistry or Chemical Engineering and should have experience in the manufacture of explosives and also in the development of chemical processes from the laboratory scale, through the semi-technical scale, up to full scale production units. Experience in the design of chemical plant, in general administration, and in the handling of labour, is essential. Write, quoting F.3886A, to the Ministry of Labour and National Service, Central (T. & S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2, for application form, which must be returned completed by April 30, 1945.

Technical Translations: Metallurgical, Chemical, etc.—from JAPANESE, GERMAN & FRENCH, by Hons. Graduate in Science. Particulars as to rates, etc., from H. J. Cant, M.Sc., 8 Clyde Road, Sutton, Surrey.

The Royal Photographic Society of Great Britain invites applications for the post of Assistant Secretary, with a view to promotion to Secretaryship of the Society. Commencing salary £750, or according to qualifications. Consideration will be given to applicants who, owing to wartime duties, cannot take up the post immediately.—Applications, which will be treated in confidence, should be accompanied by full particulars of qualifications and previous experience, and addressed to the Royal Photographic Society, 16 Prince's Gate, London, S.W.7, and the envelope marked "Assistant Secretary."

South London Firm (E.W.O.) requires a young British Physical Chemist or Physicist-Chemist with Honours Degree or equivalent, as Research Assistant for research under direction. Previous electro-chemical experience an advantage. Must be fully conversant with modern Physico-Chemical technique relating particularly to Potentiometric and Conductiometric analysis. Determination of pH and Electrode Potentials, etc. Apply stating age, sex, qualifications, previous experience, salary, to Box No. 335, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

South London Firm (E.W.O.) requires an Intelligence Office, M. or F. attached to Research Department. Fluent knowledge German essential, knowledge of other languages, especially Russian an advantage. Duties include Library and Patent Research, Translation recording, Abstracting, Indexing, etc. Apply stating age, sex, qualifications, previous experience, salary to Box No. 334 T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Works Chemist with Industrial Laboratory experience required by a progressive company. Applicant should be a University Graduate, preferably with experience of oils and fats refining. Apply stating age, qualifications, experience, position regarding National Service and salary required. Box 337, T. G. Scott & Son, Ltd., 9 Arundel Street, W.C.2.

Administrator—30, ex-Army—seeks permanent responsible appointment. Presently temporary Administrator Scientific Research Association. Experienced all branches secretarial procedure, administration, accounting. Wide experience committee and public relations work. Box P.101, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Expert Shorthand-Typist required for technical correspondence and record work in Research and Development Dept. of large metallurgical Company, London (temporarily evacuated Cheltenham). "Essential" work. Apply, stating age, education, experience, salary required, etc. to Box 338, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Assistant Director of Research required by firm of Communication Engineers, in S.W. London Area. Applicants must be thoroughly conversant with transmitted designs for medium and high frequencies. Apply Box No. 339, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Progressive Optical Engineering Company requires the services of an experienced optical designer. The duties would include original design of high quality photographic and other lenses, the design of optical systems and the training and supervision of junior computing staff. The closest collaboration with mechanical designing staff would be afforded. Please write full particulars of career and qualifications to "Optical," c/o G. L. Campbell, 123 Bedford Hill, Balham, London, S.W.12.

Applications are invited for the post of General Secretary of the Chemical Society. Salary according to experience but not less than £700 p.a. Applications (8 copies) should be addressed to the Honorary Secretaries, The Chemical Society, Burlington House, Piccadilly, W.1, by May 15, 1945, stating qualifications and administrative experience and giving the names of three persons to whom reference may be made.

Physicist, experienced in geophysical prospecting methods, required by firm of consultants. Apply, stating age, qualifications, experience, and salary required.—Box No. 342, T. G. Scott & Son, Ltd., Talbot House, 9 Arundel Street, W.C.2.

Analyst required by Genatosan Ltd. Candidate should be of Honours graduate or A.R.I.C. qualification and should have had several years' industrial experience in the analysis of medical preparations and fine chemicals. Commencing contract at £350-£450 per annum, plus 12½% war bonus.—Apply Chief Chemist, Genatosan Ltd., Loughborough.

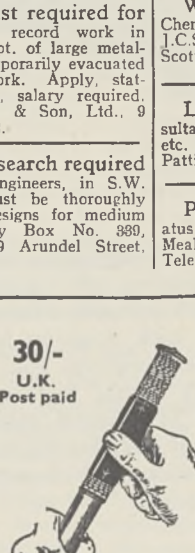
Messrs. W. Heffer & Sons Ltd., Booksellers, 4 Petty Cury, Cambridge, have a vacancy in their Scientific Department for a capable and energetic Assistant.—Apply, stating experience and salary expected.

B.Sc. in Chemistry or Metallurgy (capable of abstracting in Russian, German and French) required for London Industrial Science Library. Write full details age, experience, salary required to Box No. 340, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Wanted: Collective volumes of Chemical publications prior to 1942, e.g., J.A.C.S., J.C.S. and abstracts. Apply Box 341, T. G. Scott & Son, Ltd., 9 Arundel Street, W.C.2.

Laboratory Outfit wanted by Consultant Chemist, including Balance, Glassware, etc. Complete existing Laboratory considered. Pattison, Siddals, Derby. Tel. 45249.

Polaroid Film and photo-elastic apparatus available for priority users. H. S. B. Meakin, Ltd., 36 Victoria Street, London, S.W.1. Telephone: Abbey 6713.



PRINTED IN GREAT BRITAIN BY FISHER, KNIGHT AND CO., LTD., ST. ALBANS

scripts of sufficient importance and authenticity would also be listed. Where, however, only incidental mention is made of plant localities, as in many of the standard floras of Britain and in monographs, these would be omitted from this section. The compilation will entail a large amount of research and will be possible only with the co-operation of helpers who have the requisite local knowledge of the literature of their areas. The editors are Mr. J. S. L. Gilmour, Mr. H. A. Hyde, Mr. H. S. Marshall, Mr. N. Douglas Simpson and Dr. G. Taylor. Those willing to help in this compilation should communicate with Mr. N. Douglas Simpson, Maesbury, 3 Cavendish Road, Bournemouth, Hants, indicating when they can begin work, in what areas they are interested and to what libraries and periodicals they have access.

Early Scottish Prehistory

It is doubtful whether it can be proved that any cultures earlier than the Mesolithic existed in Scotland. This is perhaps surprising, as there would seem to have been no climatic reason why Scotland should not have been habitable during the main interglacial epoch in the middle of the Great Ice Age in any event. Maybe the scanty populations of the Old Stone Age never reached the extreme northwestern edge of the Old World. Mesolithic industries contemporary with those farther south have been unearthed at a number of sites. But many of the apparently Mesolithic industries in Scotland are actually much more recent in date and contemporary with the Neolithic or even early Metal Age farther south. Even in the Cleveland hills of Yorkshire, sites are known where pigmy tools of Mesolithic facies occur in real association with leaf-shaped arrowheads. Such an overlap of cultures is not surprising. The Neolithic civilization in Britain was rather due to the incoming of new modes of life than to hordes of invaders; in large part it was a case of 'neolithicizing' the autochthonous inhabitants. Off the beaten track, the older culture continued to survive, influenced to a greater or less degree by the more advanced ideas spreading slowly over the land.

Much of our information of these early cultures in Scotland is due to the work of A. D. Lacaille, who is collecting a corpus of material for eventual publication after the War. Recently, he gave a paper to the Society of Antiquaries of Scotland on the stone industries associated with the raised beach at Ballantrae. The sites are in Wigtownshire and south Ayrshire, and the specimens were collected on the tilled surface of the raised beach, which itself dates to the period of the Littorina Marine transgression. With the specimens of Mesolithic facies were found others, Neolithic in appearance. The evidence would seem to point to the introduction there of the Neolithic civilization towards the end of the Atlantic post-glacial phase. Among the Mesolithic types of implements occur specimens which recall some found in northern Irish sites. Thus tanged points resembling those from the valley of the River Bann have been found. Mr. Lacaille's definitive publication will be awaited with interest. There is still a lot to be learnt about the cultural overlaps in Scotland and the various influences that went to form the earliest Stone Age cultures north of the Cheviots.

Archæological Expedition to Mexico

The War has forced the National Geographic Society to curtail its scientific field expeditions, but the archæological studies that have been made annually since 1937–38 in southern Mexico under the sponsorship of the Society and the Smithsonian Institution will continue. The seventh expedition, headed by Dr. Matthew W. Stirling, is on its way to the southernmost Mexican State of Chiapas where, digging into huge burial mounds and clearing dense jungle growth, he will continue to reveal some of the secrets of pre-Columbian civilization in this hemisphere. Dr. Stirling is accompanied by his wife, Marion Stirling, who is also an archæologist, and Richard H. Stewart, staff photographer of the National Geographic Society. The expedition this year plans to conduct its studies in the mountains east of the Isthmus of Tehuantepec.

Social Implications of Engineering

On March 28, Sir Harry Railing, president of the Institution of Electrical Engineers, delivered an address to the London Students' Section of the Institution, taking as his subject the social implications of engineering. Sir Harry stressed that it is essential for the engineer to grasp the inner meaning of his work and the mission he has to fulfil in his everyday life. To do this, a full appreciation of past achievements is necessary, and he must feel that, however small or large his contribution, he is a vital unit in a powerful living force. Material progress has been so remarkable that too little attention has been paid to the development of the lives of human beings. Humanity should have been trained and encouraged to accommodate itself to the increased impetus of science and engineering, so as to avoid a disastrous piling up of pent-up energy. Engineers should have foreseen these consequences more clearly and made the world realize that increasing material knowledge necessitates the acceptance of new responsibilities both on the part of the individual, the community and the State.

Sir Harry Railing does not believe in early specialization. When specialization becomes necessary, engineers should retain a broad understanding of the work of others in as wide a field as possible. Of the relative value of the methods most useful in engineering work, mathematics and physics are of paramount importance. But engineering involves also the handling of human beings, and it vitally affects their lives. A broader understanding of sociological problems is necessary, and if the engineer's work neglects the spiritual aspect it is liable to be a dismal failure. For the well-being of the community the scientific approach should be applied to social problems and politics, but its limitation should be borne in mind. Man is finite, not infinite, and from this should spring humility and tolerance of others.

Jubilee of the *Astrophysical Journal*

With the current issue of the *Astrophysical Journal*, this periodical completes its hundredth volume. Founded in 1895 by Hale as an international review of spectroscopy and astronomical physics, the *Astrophysical Journal* soon became the acknowledged medium for the publication of research, and especially of observational research, by English-speaking astrophysicists. Although the original plan of appointing collaborating editors from countries other than the United States has been recently abandoned, the international character of the journal is still attested by its contents pages. During the past fifty years such famous names as those of Cornu, Huggins, Belopolsky, Kayser, Schuster, Newall and Alfred Fowler have appeared beside those of their American colleagues, and such contemporary names as Adams, Millikan, Russell, Shapley and Otto Struve are likely to be as well remembered in the future. Nearly all the major spectroscopic and astrophysical advances of the past half-century are recorded in the first hundred volumes: the Fabry-Perot interferometer, the Rowland solar wave-length table, the first photographic trigonometrical parallaxes and spectroscopic parallaxes, the 100-in. telescope, the Einstein and the nebular red-shifts, 'nebulium' and super-novæ, to mention only a few. With the completion of the 200-in. telescope after the War, science may look to see its boundaries enlarged yet again in the pages of the *Astrophysical Journal*.

Temperature Compensation in Instruments

A PAPER read recently in London by Dr. G. F. Tagg before the Institution of Electrical Engineers has for its theme the fact that one cause of errors in indicating and recording instruments is their use at a temperature other than that at which they were calibrated. Most of the physical properties of materials on which instrument performance depends vary to a greater or less degree with temperature. It is therefore necessary when designing an instrument to reduce to a minimum any errors caused by changes in temperature, and if possible to make them negligibly small. This is done either by adopting a design such that the temperature errors themselves are very small, or by introducing other changes with temperature which will compensate them. An account is given in the paper of the more common methods employed, each method being briefly discussed to indicate the best arrangement for each type of instrument. The instruments considered are ammeters, voltmeters, millivoltmeters, wattmeters and rectifier-operated and thermocouple instruments.

Recent Earthquakes

DURING the third quarter of 1944, fifty-eight earthquakes and tremors were recorded at Toledo, Spain, while during the same quarter twenty-six strong earthquakes were recorded at the Dominion Observatory, Wellington, New Zealand. The earthquake of October 29 was felt with Scale 5 (modified Mercalli) in the southern parts of North Island and Taumarunui; the shock of November 25 was felt at Karamea with Scale 4 and that of December 24 was felt at Timaru with Scale 3 intensity. The United States Coast and Geodetic Survey determined the epicentres of several shocks which occurred during the quarter. On October 23 the epicentre was in Ecuador, South America; on December 7 (lat. 33° N., long. 137° E.) off Japan; on December 10 in the New Hebrides Islands and on December 12 in the Aleutian Islands.

The Ray Society

AT the annual general meeting of the Ray Society held on March 22, Mr. A. D. Cotton, president of the Linnean Society, was elected a vice-president and Prof. F. Balfour-Browne, Dr. W. S. Bristowe and Dr. John Smart new members of Council. It was announced that Dr. F. E. Zeuner's volume on "The Pleistocene Period" would soon be ready for distribution, and that Dr. Dawes's work on "The Trematode Parasites of British Fishes" was nearly ready for printing. Owing to the increase in costs, Dr. Zeuner's book will form the issue to subscribers for the two years 1942 and 1943, and it is intended that Dr. Dawes's volume shall be issued for the year 1944. Other works are in preparation, but no dates can yet be announced for their probable publication.

Oliver Lodge Scholarship

IN order to commemorate the silver jubilee of the Radio Section of the Institution of Electrical Engineers, the Council of the Institution has founded a research scholarship which is to be called the Oliver Lodge Scholarship. It will have a basic annual value of £250 and will be tenable for one year, but may be extended for a second year. The Council wishes to encourage scholars to travel and, after approval of a candidate's programme, may make an additional grant for this purpose. The scholar will be required to carry out research in a subject closely allied to radio engineering. Further particulars and nomination forms can be obtained from the Secretary, Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2. The closing date for receiving nominations is May 15, 1945.

Announcements

THE following have been elected by the Governing Body to honorary fellowship of the Imperial College of Science and Technology: the Most Hon. the Marquess of Crewe, Mr. C. S. Garland, Mr. Percy Good, Dr. Andrew McCance, the Right Hon. Lord Rayleigh, Prof. J. S. Truscott, Lieut.-General Sir Pierre Van Ryneveld, Prof. W. W. Watts, Prof. A. N. Whitehead and Dr. H. E. Wimperis.

MR. O. S. PUCKLE, recently of the Research Department of Messrs. A. C. Cossor, Ltd., has been appointed chief engineer of R. F. Equipment, Ltd., Plantation Road, Amersham, Bucks, with a seat on the board. In particular he will be responsible for research and development.

THE posts of inspector-general of forests to the Government of India and president of the Forest Research Institute and Colleges have been separated. A separate post of president of the Forest Research Institute and Colleges, Dehra Dun, has been created; this post is being filled by Mr. C. E. Simmons. The inspector-general of forests (Sir Herbert Howard), with his office and staff, has been transferred to New Delhi. His address in New Delhi will be "Inspector-General of Forests, Department of Education, Health and Lands, New Delhi", and his telegraphic address will be "Igforest, New Delhi". All correspondence connected with research and education at Dehra Dun should be addressed to the President, Forest Research Institute and Colleges.

TRINITY COLLEGE, Cambridge, has decided to resume in the present year the annual offer of a research studentship which has been suspended since 1941. The studentship is open to graduates of other universities who propose to go to Cambridge as candidates for the degree of Ph.D., provided that on June 1, 1945, they have not commenced residence in the University of Cambridge and are not more than twenty-six years of age. In computing the age of a candidate for this purpose, any days of war service will be deducted from his actual age. Candidates should apply through the principal authority of their university, and applications should reach the Senior Tutor of Trinity College (from whom further particulars may be obtained) before June 1, 1945.

LETTERS TO THE EDITORS

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

Adhesion of Lubricated Metals

IT is evident, both from an examination of the contours of solid surfaces, and from measurements of the electrical conductivity between metals[1], that the real area of contact between two surfaces is only a small fraction of the apparent area of contact. This means that even with quite small loads very large pressures will be developed at the few points of real contact. It has been shown that these pressures are sufficient to cause local adhesion and welding of the surfaces at the points of contact, and that the tangential force required to shear the junctions is a major component of the friction between sliding metals[2].

The reality of this metallic welding may be demonstrated by a microscopic examination of sections of the track, and an example of this is given in Fig. 1. A curved copper slider was allowed to slide once (at low speed, 0·01 cm. per sec.) over a mild steel surface. The load was 4,000 gm. and the experiment was done both with clean and with lubricated surfaces. When the surfaces were clean, the coefficient of friction was high ($\mu = 0{\cdot}6$–$0{\cdot}7$) and many tiny particles of copper were left adhering to the steel. Fig. 1 is a photomicrograph of a taper section of one of these particles. It was made by protecting the steel surface with an electro-deposit and cutting a section at a very oblique angle so that the magnification of the vertical component of the surface contour was ten times that of the horizontal component. A modification of the technique described by Nelson[3] was used. In this photograph the vertical magnification is 5,000 and the horizontal 500. It will be seen that the copper is welded firmly on to the steel, and the shearing of the copper has caused a plucking up of the steel above the general level of the surface. This would lead to a wearing away of the steel, and shows graphically how a hard metal can be worn by a soft one.

Fig. 1. TAPER SECTION SHOWING COPPER FRAGMENT (DARK) WELDED ON TO STEEL SURFACE; NOTE PLUCKING UP OF STEEL. VERTICAL, × 5000; HORIZONTAL, × 500.

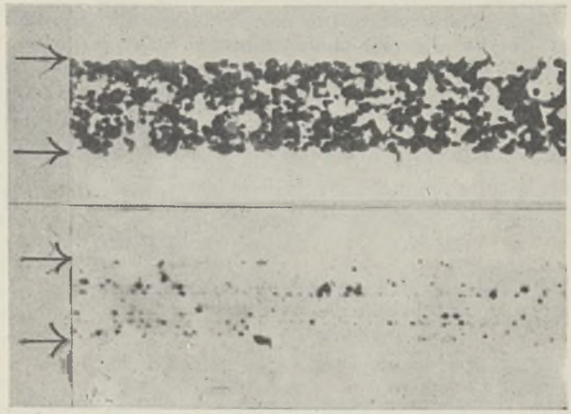


Fig. 2. CHEMICALLY DEVELOPED TRACK OF COPPER SLIDER ON A CLEAN (ABOVE) AND LUBRICATED (BELOW) FLAT STEEL SURFACE. THE TRACK LIES BETWEEN THE ARROWS, WHICH SHOW DIRECTION OF SLIDING. BLACK AREAS ARE COPPER. × 11.

When the metals are lubricated, the friction falls to about $\mu = 0{\cdot}15$. The earlier frictional and conductivity experiments have shown that metallic contact and adhesion still occur through the lubricant film, but they are, of course, greatly reduced and difficult to detect by the taper section method. The existence of this localized adhesion and its distribution over the surface of the track may, however, be revealed by a chemical technique using a method similar to that described by Hunter, Churchill and Mears[4] for the detection of metallic inclusions. A gelatine-coated paper which has been immersed in a suitable electrolyte is placed on the surface of the metal to be examined and a current passed so that the foreign metal is electro-dissolved into the gelatine. If an appropriate reagent is present in the gelatine, very small quantities of metal may be detected. In this case dithio-oxamide was used to detect copper, and Fig. 2 shows the patterns obtained by allowing the copper slider to pass once over polished steel (*a*) when clean and (*b*) when lubricated with 1 per cent lauric acid in paraffin. The black areas indicate copper, and it will be seen that the adhesion of copper to the lubricated steel surface is quite considerable. The track of the slider is about 1 mm. wide, and adhesion has occurred at a number of small points distributed over it. There is a tendency for these points to lie on straight lines in the direction of sliding, and this probably corresponds to high spots on the copper slider.

Similar experiments of a more quantitative nature were carried out with copper on platinum, both clean and lubricated with solid potassium stearate. Any copper adhering to the flat platinum surface after the copper slider had passed over it once was removed electrolytically from an appropriate length of track and micro-estimations made with sodium diethyl dithiocarbamate. With the clean metals the friction was high and irregular ($\mu \sim 1{\cdot}8$) and the surface density of copper adhering to the platinum was 2×10^{-5} gm. per mm.^{2} of track. With lubricated metals the amount of copper adhering to the platinum was $1{\cdot}7 \times 10^{-7}$ gm./mm.^{2}. If this copper were spread evenly over the platinum in the path of the slider, it would correspond to a layer about fifty atoms thick; but as the photographs show, it is distributed irregularly over the surface of the track in a number of small discrete particles of varying size.

In a recent interesting paper, Sackmann, Burwell and Irvine[5] describe the application of a radioactive method to the measurement of the pick-up of metals. Their results are not directly comparable with ours since they measure the amount of metal which accumulates on the small curved surface of the slider after it has traversed a certain distance; but again the results confirm the observation that metallic adhesion occurs through the lubricant film.

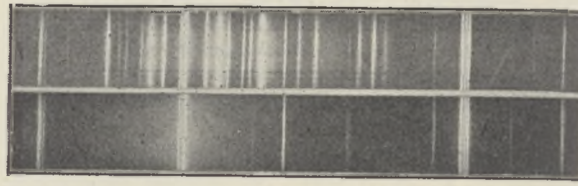
F. P. BOWDEN.
A. J. W. MOORE.
Council for Scientific and Industrial Research,
University of Melbourne.
Dec. 1.

[1] Bowden and Tabor, *Proc. Roy. Soc.*, A, 169, 391 (1939).
[2] Bowden, Moore and Tabor, *J. Appl. Phys.*, 14, 80 (1943).
[3] Nelson, Conference on Friction and Surface Finish, Mass. Inst. Tech., 217 (1940).
[4] Hunter, Churchill and Mears, *Met. Prog.*, 42, 1070 (1942).
[5] Sackmann, Burwell and Irvine, *J. Appl. Phys.*, 15, 459 (1944).

Raman Spectrum of Quartz

SINCE quartz is transparent in the ultra-violet, the employment of the powerful technique for Raman-effect studies developed by Rasetti, in which the 2537 A. radiation from a water-cooled magnet-controlled mercury arc is the exciter, naturally suggests itself for this crystal. Rasetti's own studies[1] included quartz, but his exposures were very short (20 min.) and it is therefore not surprising that he recorded only fourteen distinct frequency shifts as against the twenty shifts found earlier by Gross and Romanova[2] with the 4358 A. radiation of the mercury arc as the exciter and exposures of the order of 120 hours. However, by prolonging the exposure with the Rasetti technique to 48 hours for a crystal 15 cm. long, I have recorded a very intense spectrum reproduced herewith, in which no fewer than forty-one distinct frequency shifts have been observed and measured. All the twenty-one newly observed frequency shifts are represented by relatively feeble lines and evidently belong to the Raman spectrum of the second order, namely, octaves and combinations of the fundamental frequencies of the quartz lattice. The accompanying table gives the measured frequency shifts in wave-numbers, the relative intensities of the lines being roughly indicated on an arbitrary scale within brackets.

Frequency shift and strength	Assignment	Frequency shift and strength	Assignment
127 (20)	E_1	859 (1)	
145 (2)		890 (1)	$B_2 + E_3$
207 (15)	A_1	925 (1)	$E_1 + E_5$
267 (7)	E_2	940, 960 (1)	$2A_3$, $2B_2$
319 (1)		1033 (1)	
358 (6)	A_2	1065 (4)	E_6
395 (5)	$E_1 + E_2$	1082 (3)	A_4
404 (5)	E_3	1134 (1)	
453 (2)		1160 (7)	E_7
467 (30)	A_3	1228 (3)	E_8
480 (2)	(B_2)	1248 (1)	
500 (2)		1276 (0)	$A_1 + E_6$
520, 546 (1)	$E_1 + E_3$, $2E_2$	1369 (0)	$A_1 + E_7$
585 (1)	$A_1 + B_1$	1381 (0)	
645 (1)		1429 (0)	$E_2 + E_7$
670 (0)	$E_2 + E_3$	1456 (0)	$B_4 + E_2$
696 (4)	E_4	1570 (0)	$B_1 + B_4$
727 (0)	$A_3 + E_2$	1610, 1630 (1)	$2B_3$, $A_3 + E_7$
794 (5)	E_5	2379 (1)	$2B_4$
805 (5)	$2E_3$, (B_3)	2430 (1)	
834 (1)			



ABOVE, RAMAN SPECTRUM OF QUARTZ. BELOW, COMPARISON SPECTRUM OF MERCURY ARC.

According to Bishambar Dayal Saksena[3], the group of three silicon and six oxygen atoms present in the unit hexagonal cell of the quartz lattice has sixteen distinct fundamental modes of vibration, four of the A class active only in Raman effect, four of the B class active only in infra-red and eight of the E class active in both. The fundamentals shown as such in the table are distinguished by their relatively large intensities, and those of the A class by the strong polarization of the lines. The four fundamental frequencies coming under the B class have been assumed from the infra-red measurements of Plyler[4] as $B_1 = 385$, $B_2 = 488$, $B_3 = 800$ and $B_4 = 1,190$ wave-numbers. The identifications of some of the weaker lines as overtones and allowed combinations are shown in the table, but are only provisional.

R. S. KRISHNAN.
Physics Department,
Indian Institute of Science,
Bangalore.
Feb. 12.

[1] Rasetti, F., *Nuovo Cimento*, 9, 72 (1932).
[2] Gross and Romanova, *Z. Phys.*, 55, 744 (1929).
[3] Bishambar Dayal Saksena, *Proc. Ind. Acad. Sci.*, A, 12, 93 (1940).
[4] Plyler, *Phys. Rev.*, 33, 48 (1929).

Absorption Spectra of Mercury Halides

RAO[1] has recently observed the absorption spectra obtained when halides of mercury were placed in a heated steel tube. New systems attributed to HgCl and HgBr were found and analysed, leading to values for the dissociation energies of these molecules. Comparison of the wave-lengths of these 'new' bands with tables[2] of collected band heads of known molecules reveals coincidences with CuCl and CuBr. More detailed comparison shows that Rao's Q_1 heads of 'HgCl' coincide with the D system of CuCl, and the Q_2 heads with the E system. For 'HgBr' all the assigned band heads can be identified with the B system of CuBr; other unassigned bands of 'HgBr' coincide with bands of the A system of CuBr. The identity is quite convincing.

In Rao's experiments the copper probably came from the steel tube. I have observed[3] CuCl bands in the spectrum of a flame burning in a steel tube. The identification of the emitting molecule of a new band system is not easy, but it is not always realized that impurities as frequently cause trouble in absorption as in emission. It seems desirable to point out incorrect assignments of this type to save later investigators wasting time, and possibly using incorrect data for theoretical work.

A. G. GAYDON.
Chemical Engineering Department,
Imperial College,
London, S.W.7.

[1] Rao, A. L. S., *Indian J. Phys.*, 16, 393 (1942).
[2] Pearse, R. W. B., and Gaydon, A. G., "The Identification of Molecular Spectra" (Chapman and Hall, London, 1941).
[3] Gaydon, A. G., *Proc. Roy. Soc.*, A, 182, 199 (1943).

Inverse Statistical Variates

HALDANE[1] has recently explained a method of using a hæmacytometer in which counting is stopped when a fixed number of cells has been recorded. This sampling technique, with suitable modifications, can be applied to other populations and the theory reveals some interesting relationships.

In ordinary binomial sampling, if the variate (r) is the number of occurrences of a certain event when it is given a fixed number (N) of opportunities of occurring, in each of which the probability of occurrence is π, then the seminvariant-generating function of r is

$$L_N(t) \equiv \ln\sum_{r=0}^{N} e^{-rt}({}^NC_r)\pi^r(1-\pi)^{N-r} = N\ln(1-\pi+\pi e^{-t}) = NL_1(t).$$

If, however, the number of occurrences is fixed (R), the probability that n opportunities will be required is equal to the probability that the event will occur $R-1$ times in the first $n-1$, compounded with the probability of an occurrence at the nth opportunity. Hence it is

$$\frac{(n-1)!}{(R-1)!\,(n-R)!}\pi^R(1-\pi)^{n-R},$$

(the coefficients being those of the expansion of a binomial of power $-R$), and the seminvariant-generating function of n can be shown to be $-R\ln\left(1-\frac{1-e^t}{\pi}\right)$. This seminvariant-generating function is simply $RL_1^{-1}(t)$, where $L_1(L_1^{-1}(t)) \equiv t$—a rather striking result. Moreover, the coefficients of variation of r and n are equal when $R = N\pi$. In this case, the value of R in the distribution of n is the mean value of r, while the value of N in the distribution of r is the mean value of n. In view of these relationships between the two distributions, I suggest that the sampling with a fixed number of occurrences should be termed *inverse binomial sampling*.

The Poisson limit is obtained on writing $\pi = k\mu$, $x = nk$, $X = Nk$, and then making k vanish while x, X and μ remain finite. The seminvariant-generating functions of r and x become $X\mu(e^{-t}-1)$ and $-R\ln(1+t/\mu)$, which are of the form $Xf(t)$, $Rf^{-1}(t)$, where $f(f^{-1}(t)) \equiv t$; and the coefficients of variation are equal when $R = X\mu$. The first of these seminvariant-generating functions is that of the usual Poisson limit, while the second corresponds to a distribution of Pearson's Class III, in which the variate can take any non-negative value, and such a distribution could therefore be termed the *inverse* of the Poisson distribution. That inverse Poisson sampling with $R = 1$ gives a Class III distribution of this type has already been shown by Marsden and Barratt[2].

A similar relation appears in the theory of the effect of Brownian motion on the times taken by colloid particles to travel a fixed distance under electrophoresis or convection. The general theory, developed by using the properties of seminvariant-generating functions, will be published elsewhere, but a result relevant here is that if a number of particles are released in a plane at time $\eta = 0$ and the distribution of their distances from this plane is Gaussian with variance $\beta\eta$ after a time η, β being a constant—so that, if their mean moves with constant velocity ω, the seminvariant-generating function of their displacements (x) from the original plane is $\eta(-\omega t + \frac{1}{2}\beta t^2)$, which is equal to $\eta F(t)$, say—then the seminvariant-generating function of the times (y) taken by the individual particles to reach a parallel plane at a distance ξ is

$$\xi F^{-1}(t) = \xi(\omega - \sqrt{\omega^2+2\beta t})/\beta.$$

The corresponding distribution function has been given by Schrödinger[3] and Smoluchowski[4], who derived it by a different method. The coefficients of variation of x and y are equal when $\xi = \eta\omega$.

In general, if a variate x has the seminvariant-generating function $\alpha L(t)$, and another variate y the seminvariant-generating function $\beta L^{-1}(t)$, then their means are respectively $\alpha\varkappa_1$ and $\beta/\varkappa_1$ and their variances $\alpha\varkappa_2$ and $\beta\varkappa_2/\varkappa_1^3$, where $\varkappa_1$ and $\varkappa_2$ are the first and second seminvariants of the seminvariant-generating function $L(t)$. The coefficients of variation are equal if $\beta = \alpha\varkappa_1$, so that the mean value of x is β, while that of y is α. Thus, when the seminvariant-generating functions of x and y are so related, and the accuracy is measured by the coefficient of variation, y/β is as accurate an estimate of $1/\varkappa_1$ as x/α is of $\varkappa_1$. Further, if the coefficient of variation is small, it is approximately the same for β/y, which is therefore as good an estimate of $\varkappa_1$ as x/α. I suggest that two variates related as x to y should be termed *inverse variates*, and either distribution may be said to be the inverse of the other.

I have been able to prove that the seminvariant-generating functions must be related in this way in the case of the Brownian motion problem, even when the latter is generalized by the removal of the assumption that the particles spread out on either side of their mean in a Gaussian manner. On the other hand, I have not been able to formulate a general sampling rule by which the inverse variate can be obtained from a given group of distributions, so that the definition of inverse variates remains a relation between their seminvariant-generating functions and between their means.

M. C. K. TWEEDIE.

Radium Centre,
North Staffordshire Royal Infirmary,
Stoke-on-Trent.

Jan. 22.

[1] Haldane, *Nature*, 155, 49 (1945).

[2] See Rutherford, Chadwick and Ellis, "Radiations from Radioactive Substances" (1930), §34c.

[3] Schrödinger, *Phys. Z.*, 16. 289 (1915).

[4] Smoluchowski, *Phys. Z.*, 16, 318 (1915).

MR. TWEEDIE's demonstration of the relation between the seminvariant-generating (or cumulant-generating) functions of two sets of related distributions is of great interest. However, the word "inverse" is already used in statistical theory, first in the phrase "inverse probability", and secondly in connexion with the problem of finding a distribution with a given characteristic function. If it is used in yet a third sense, some confusion may possibly arise, although "inversion" is already used in geometry and algebra with different meanings, and without inconvenience. It may be added that Mr. Tweedie's letter does not give an alternative solution of the problem raised by my own, since I am concerned with the distribution, not of n, but of $\frac{R-1}{n-1}$, which gives an unbiased estimate of the probability π.

J. B. S. HALDANE.

Department of Biometry,
University College,
London.

Bacteriological Studies of Pinosylvine, its Monomethyl and Dimethyl Ethers, and Toxicologic Studies of Pinosylvine

CONTRARY to what is true of sap-wood, pine heart-wood cannot be digested by the normal sulphite method. The cause of this has often been discussed. Investigations, especially by Hägglund and his co-workers, eventually disclosed that the cause must lie in the presence of certain substances in the heart-wood which can be extracted by suitable solvents.

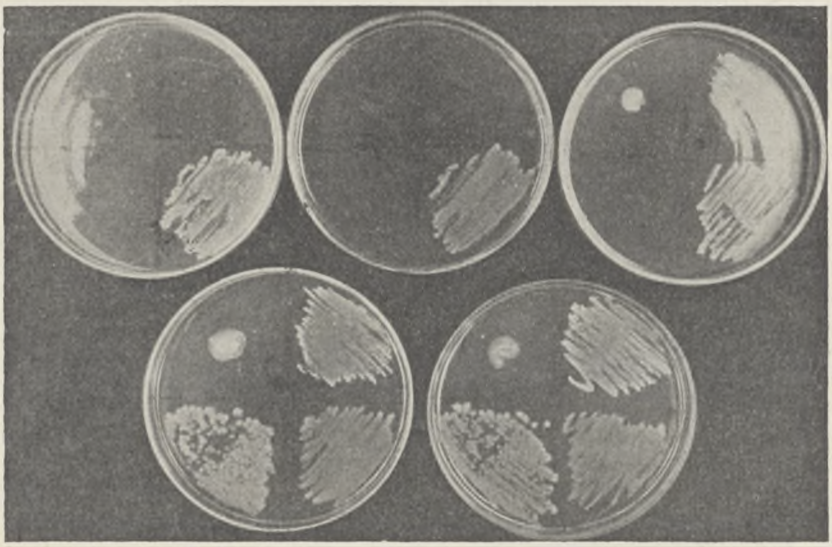
In 1939, Erdtman isolated from such extracts two phenol substances which had not been described earlier, namely, pinosylvine (*trans*-3 : 5 dioxystilbene, $C_{14}H_{12}O_2$), and its monomethyl ether (*trans*-3-oxy-5-metoxystilbene, $C_{14}H_{11}O(OCH_3)$). The name is derived from *Pinus sylvestris*.

The physiological importance of the pinosylvine substances lies in the fact that they protect the dead heart-wood against wood-decaying fungi and insects. Pinosylvine is closely related to resorcine and its derivatives, 4-hexyl-resorcine being a well-known antiseptic. Pinosylvine may therefore be expected to have a bactericidal effect. Its toxicity was already observed by Erdtman in one of his experiments. He released some aquarium fishes, *Lebistus reticulatus*, in a weak solution of pinosylvine (0·002 per cent). The fishes died rapidly.

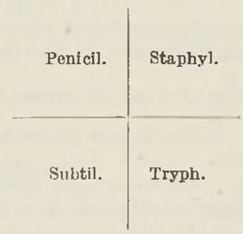
The toxicity of the pinosylvine substances in relation to wood-decaying fungi was investigated by Rennerfelt in 1943. Jorpes has tested the œstrone effect of pinosylvine, this in view of its relationship to stilbene, but he could demonstrate no such effect.

As no bacteriological and no additional toxicological studies have been made of the pinosylvine substances, the accompanying table gives a summary of my investigations carried out during 1943–44.

1 : 5,000 1 : 10,000 1 : 20,000



1 : 50,000 1 : 100,000



Pinosylvine and pinosylvine monomethyl ether are thus derivatives of stilbene and belong to a group of natural products which is as yet very small. Like stilbene, pinosylvine displays a bright violet fluorescence in ultra-violet light. Pinosylvine is very difficult to dissolve in water, its monomethyl ether still more so. On the other hand, these substances are easy to dissolve in alcohol, acetone and ether. The dimethyl ether is practically impossible to dissolve in water. The melting point of pinosylvine is 156° C., that of its monomethyl ether 122–123° C.

The table demonstrates the bactericidal effect of pinosylvine and its monomethyl ether as compared with that of phenol.

The accompanying figure shows the bactericidal effect of different concentrations of pinosylvine on bacteria cultivated on agar.

A summary of the results of all the bacteriological studies made of pinosylvine substances discloses that

		1/500	1/1,000	1/2,000	1/5,000	1/10,000	1/20,000	1/50,000	1/100,000	Aq.
Pinosylvine	*B. staphyloc. aureus*				−	−	±	+	+	
	Penicillium				−	−	±	+	+	
	B. subtilis (spores)				−	−	−	+	+	
	B. typhi murium			−*	+	+	+	+	+	
Monomethyl-ether	*B. staphyloc. aureus*				−	−	±	+	+	
	Penicillium				−	−	±	+	+	
	B. subtilis (spores)				−	−	−	+	+	
	B. typhi murium			+*	+	+	+	+	+	
Phenol	*B. staphyloc. aureus*	−	−	±	+	+				
	Penicillium	−	−	±	+	+				
	B. subtilis (spores)	−	±	±	+	+				
	B. typhi murium	−	±	+	+	+				
Aq.	*B. staphyloc. aureus*									+
	Penicillium									+
	B. subtilis (spores)									+
	B. typhi murium									+

* In earlier experiments.

the inhibiting and bactericidal effect of pinosylvine is 7–30 times as strong as that of phenol in respect of *B. typhi murium*, about thirty times as strong in respect of *B. staphylococcus aureus*, and about forty times as strong in respect of spores of *B. subtilis*. The inhibiting and bactericidal effect of pinosylvine monomethyl ether is about three times as strong as that of phenol in respect of *B. typhi murium* and about ten times as strong in respect of *B. staphylococcus aureus*. Pinosylvine dimethyl ether, finally, has no demonstrable bactericidal effect, probably owing to it not possessing any group of free hydroxides. Pinosylvine and its monomethyl ether thus appear to possess the strongest bactericidal qualities hitherto demonstrated in any phenol compound found in Nature and isolated.

The toxicological investigations showed that the minimum lethal dose, calculated for a mouse of 15 gm., is 1–2 mgm. pinosylvine in a 10 per cent alcohol solution, injected intraperitoneally. For the sake of comparison it may be mentioned that the corresponding value for phenol in water is 2·5 mgm. injected subcutaneously. The toxic effect of pinosylvine is thus stronger than that of phenol and at the same time the poisoning symptoms are different, there being no convulsions.

Details of this work will be published in the *Nordisk Hygienisk Tidskrift*.

K. O. Frykholm.

Department of Industrial Hygiene,
Institute of Public Health,
Stockholm.

Effects of Thiourea and Allylthiourea on the Germination of the Seed of *Striga lutea*

Striga lutea is a parasite belonging to the Scrophulariaceæ which attacks the roots of a number of crop plants. As with some other closely allied species, the seeds will germinate normally only after exposure to a stimulant produced by a host root[1]. Observations, however, on the effects on germination of a series of substances known to have biological activity in other connexions indicate that the host stimulant may be replaced, to a limited extent, by certain comparatively simple compounds. The experiments in which these observations were made involved incubating parasite seeds at 22° C. for twenty-one days on moist filter paper, transferring them to another culture vessel provided with filter paper moistened with a solution of the experimental substance, incubating for a further period of some days at 22° C., and finally exposing the culture to 34° C. for 24–48 hours. Thus the experimental process embodied three separate phases, each necessitated by a particular condition; the first by the fact that the parasite seed reacts vigorously to the host stimulant only after exposure to moisture for some days; the second by the effect of immediate exposure to the higher temperature with the substitute stimulant, which is that of inhibiting germination; and the third by the fact that neither with the normal nor with the substitute stimulant does extensive germination occur at the lower temperature, however prolonged is the period of incubation.

The effects of some forty-two compounds were examined, and of these only two—thiourea and allylthiourea—promoted any germination in the absence of the host stimulant. Thiourea was the less effective of the two; by treating the seed with a 1 per cent solution for three days in the second phase, and afterwards incubating for twenty-four hours in the third, a percentage germination of 36·9 was obtained. This, however, was an exceptional result; a variety of other treatments was tried, but they all gave considerably lower values.

The results in terms of percentage germination of an experiment with allylthiourea, in which the variables were solute concentration, the duration of the second phase, and the duration of the third, are given in the accompanying table.

Clearly the effect of the higher concentration is more rapid than that of the lower in that it yields the highest germination with two days, whereas the lower does so with five days of second-phase treatment. With both concentrations germination increases as the third phase is extended from twenty-four to forty-eight hours, and with both, prolongation of the second phase after a peak value is reached tends to depress germination. The effect of allylthiourea may be compared with that of the natural stimulant. Seeds exposed to the same treatment in the first phase as were those with which the values of the table were obtained gave after exposure to a host stimulant solution for six hours, followed by incubation with distilled water at 34° C. for twenty-four hours, a percentage germination of 80·6. The treatment with the host factor for six hours corresponds to the second-phase treatment with the substitute, which extends over days. The concentration of the host stimulant used was unknown, but certain evidence suggests that it was certainly not greater than 1 part per 1,000,000. Thus, not only does the normal stimulant yield a higher percentage germination, but also it is effective at a very much lower concentration and acts very much more rapidly than allylthiourea. The differences are undoubtedly great, and they suggest corresponding differences in the chemical characteristics of the natural and substitute stimulants.

The present series of results are of some significance in relation to earlier reports on the breaking of dormancy in potato buds[2], maple seeds, acorns[3] and lettuce seeds[4,5,6] with thiourea and in lettuce seeds with allylthiourea[4]. In particular it may be noted that Thompson and Kossar, and later Rayleigh, found that thiourea has an inhibiting effect on the growth of the seedling, which according to the latter is avoided by washing the seeds after treatment for some hours with the stimulant. In the course of the present investigation a similar phenomenon has also been noticed. The effect of both substances is apparently twofold; at certain concentrations germination is induced, but although the seed coat is broken by a slight extension of the radicle, the latter, instead of

Duration of 2nd phase in days	1		2		3		4		5		6	
Duration of 3rd phase in hours	24	48	24	48	24	48	24	48	24	48	24	48
1·0 per cent solution	56·6	64·5	57·5	68·3	45·7	54·3	47·3	58·9	3·5	8·1	4·1	7·3
0·1 per cent solution	3·2	5·9	2·3	4·8	43·5	52·3	48·3	62·1	51·8	58·5	25·3	38·3

elongating, tends to form a spherical mass of tissue to which longitudinal growth is restored by washing the seeds in distilled water. In these cases growth is inhibited, but in certain others an inhibitory effect on germination itself may also be demonstrated. With prolonged exposure to the stimulant in the second phase, as indicated by the data presented above, germination tends to decrease, but here again washing the seeds before exposure to a higher temperature in the third phase frequently restores a high percentage germination to the sample.

The similarity between the effects of the two substances on the development of dormant organs, and on the germination of the seed of *Striga lutea*, suggests a corresponding similarity in the internal conditions of the dormant organs and of the parasite seed before exposure to the host stimulant. On the other hand, it must be emphasized that the similarity is not close, since many substances which break dormancy have no effect on the parasite seed. For example, while Thompson and Kossar found that thiosemicarbazide, thioacetamide, ammonium thiocyanate, and potassium thiocyanate were also effective in inducing germination in dormant lettuce, the same substances have no effect with the seed of *Striga lutea*.

R. BROWN.
M. EDWARDS.

Botany Department,
The University,
Manchester.

[1] Brown, R., and Edwards, M., *Ann. Bot.*, 8, 131 (1944).
[2] Denny, F., *Bot. Gaz.*, 81, 297 (1926).
[3] Deuber, C. G., *Science*, 73, 320 (1931).
[4] Thompson, R. C., and Kossar, W. F., *Plant Phys.*, 14, 567 (1939).
[5] Rayleigh, G. J., *Science*, 98, 538 (1943).
[6] Thompson, R. C., *Science*, 100, 131 (1944)

Purification of Anterior Pituitary Corticotrophic Hormone

IN the course of attempts to purify the corticotrophic hormone of the pituitary anterior lobe in the past few years, it was noted that the corticotrophic hormone shows far greater solubility in alcohol than other pituitary anterior lobe principles ; it was also found to be more thermostable. Fresh pituitaries were therefore refluxed with ten times their weight of absolute ethyl alcohol (final alcohol concentration about 95 per cent) at pH 5. Such extracts gave a far higher yield of corticotrophic activity than any other extraction method previously employed ; but the most interesting fact found in connexion with the hot alcoholic extraction of the glands was that, on being filtered and cooled, the extract deposited a considerable amount of solid matter which quickly settled. The corticotrophic activity of both the supernatant fluid and of the deposit were estimated by the method of Reiss *et al.*[1]. A considerable amount of corticotrophic activity was found in the fluid, but it was of particular interest that the acetone-dried deposit contained an unexpectedly high amount of corticotrophic hormone. Other anterior pituitary biological activity could not be found.

The supernatant liquid yielded—after concentration *in vacuo*—a further amount of solid material, which was also found to have a high degree of corticotrophic activity. We deduce, therefore, that the corticotrophic fraction is comparatively very soluble in warm alcohol, but sparingly soluble in cold alcohol.

The advantage of this method of purifying the corticotrophic principle would seem to be that an active corticotrophic hormone fraction is obtained which contains relatively little inert material or other anterior pituitary hormone.

The acetone-dried deposit can be completely dissolved in warm glacial acetic acid and such a solution forms, on cooling, a partly crystalline precipitate. The further fractionation of the partly crystalline material and the investigation of its biological activity are being carried out.

MAX REISS.
Y. M. L. GOLLA.

Endocrinological Department,
Burden Neurological Institute,
Bristol.
Feb. 16.

[1] *Endokrin.*, 18, 1 (1936).

Possible Synergistic Effect of Cod Liver Vitamin D on Synthetic Vitamin D_3

Stott and Harris suggest[1] that "when synthetic vitamin D_3 is blended with cod liver oil the assay, in international units, is higher than the calculated figure", and cite two typical results of tests using eighteen pairs of rats in each assay. They also cite the average figures for thirteen blends of cod liver oil; but there is some ambiguity as to whether the averages also apply to the calculated and ascertained potencies of the resulting mixtures.

While their conclusion is of course not impossible, prudence would suggest that if it is to be generally accepted, further and more precise data should be provided. Although it is clear from the context that the biological tests used depend on the cure of experimental rickets in the rat, the authors do not mention the precise method used.

Assuming either of the British Pharmacopoeia methods to have been used, the fiducial limits at $p = 0{\cdot}99$, using ten pairs of rats, may be as wide as 49–215 per cent[2], but much will obviously depend on the precision attained in Stott and Harris's own laboratory. No indication of this is given. The point is of especial importance because no fewer than three biological assays enter into each comparison, namely, assays of the original oil, the vitamin D_3 concentrate and the final mixture.

With fiducial limits of the order of those cited in the British Pharmacopoeia—which may be even wider in the tests under discussion—it is obvious that many repetitions would be needed before an interesting possibility could be regarded as a statistically significant finding.

Further information should also be provided as to the genesis of the figures for the "synthetic vitamin D_3". This is presumably the commercial product which is, strictly speaking, not synthetic at all and which is normally assayed and sold—as required by law—in terms of B.S.I. units, not in terms of international units. Stott and Harris's use of the term 'international units' in this context presumably implies that they have re-assayed it on rats before use. If so, it would be of interest to see a comparison between the assay in B.S.I. units, on which the concentrate was purchased, and their assay in international units. If, on the other hand, no re-assay has been carried out, then the use of the term 'international units' is not justified.

In this latter contingency, the possibility of an under-estimate of the potency of the vitamin D_3 concentrate is by no means negligible. The B.S.I. test—with or without minor modifications—has been carried out in these Laboratories for the past eight years, and I am indebted to my colleague, Dr. M. D. Wright, for the information that the accuracy normally attained is indicated by fiducial limits at $p = 0{\cdot}99$ of approximately 75–133 per cent. It is, therefore, possible—especially in view of the strict legal requirements as to potency declarations associated with these oils—that the vendor of the 'synthetic' vitamin D_3 may have deliberately sold it on the basis of a very conservative estimate of potency. It is suggested therefore that before Stott and Harris's conclusions are generally accepted, much more detailed information should be provided by them on this and the other points raised.

H. C. H. GRAVES.

Research Laboratories,
Vitamins, Ltd.,
23 Upper Mall,
Hammersmith,
London, W.6.

[1] *Nature*, 155, 267 (1945).
[2] British Pharmacopoeia, 597 (1932), and Addendum (1936).

Pollen of Lime (*Tilia* spp.)

POLLEN production in small-leaved lime (*Tilia cordata* Mill.), as the following figures show[1], is comparable with that of durmast oak (*Quercus petraea* Liebl.):

Pollen output	*Tilia cordata*	*Quercus petraea*
Single flower	43,500	41,200
Ten-year-old branch system	89×10^5	111×10^6
Total for a pure stand 100 × 100 m.	$5,600 \times 10^9$	$3,500 \times 10^9$
50-year total for a similar stand	$280,490 \times 10^9$	$34,410 \times 10^9$

Oak is a typically anemophilous tree, and its pollen production in certain years at least is well known to be correspondingly high: the figures therefore need no comment. Two other groups of facts bespeak the importance of pollen production in *Tilia*:

(1) Lime pollen occurs in quantity in English and Welsh peat deposits covering a long period of post-glacial time, and its presence in substantial proportion is held by Godwin[2] to characterize the warmest phase of that period. Pollen analysis of a peat from the East Moors, Cardiff[3], showed that at one horizon 56 per cent of the total tree pollen was lime.

(2) Lime pollen is present at certain times in considerable quantity in the atmosphere near lime trees and can be caught on adhesive surfaces exposed in the vicinity. Thus the following quantities of *Tilia* and other pollen (mainly grass) respectively were caught on 5 sq. cm. of a slide exposed horizontally on the roof of the National Museum of Wales, Cardiff (60 ft. above ground) on the dates stated[4]: 1942, June 29–July 1 (48 hours), *Tilia* 174, other pollen 834; July 1–2 (24 hours), 274 and 222; July 2–3, 49 and 306; 1943, June 30–July 1, 34 and 97. Similar counts were obtained from slides exposed for us, by the courtesy of Prof. F. T. Brooks, on the roof of the Botany School, Cambridge, in 1943, namely, June 26–28, *Tilia* 173, other pollen 193; June 28–29, 36 and 60; June 29–30, 66 and 94.

So far from producing little pollen (as claimed by Yate Allen in the statement quoted by Mr. Cartwright Farmiloe[5]) lime seems to be an outstanding example of a plant which, notwithstanding the fact that its flowers produce nectar and are regularly visited by insects in consequence, yet produces and sheds also an abundance of pollen.

H. A. HYDE.

National Museum of Wales,
Cardiff.

D. A. WILLIAMS.

Llandough Hospital,
Cardiff.

[1] Erdtman, G., "An Introduction to Pollen Analysis" (Waltham, Mass., 1943).
[2] *New Phyt.*, 39 (1940).
[3] Hyde, H. A., *Trans. Cardiff Nat. Soc.*, 69 (1936).
[4] Hyde, H. A., and Williams, D. A. (unpublished).
[5] *Nature*, 155, 80 (1945).

Naga, Naja, Naia or Naya?

IN paragraph 19 of the review in *Nature* of October 21, 1944, of "The Fauna of British India", Colonel Wall states: "The generic name of the cobra should be altered to *Naga*. It was clearly the intention of Linnaeus to attach to it the name by which it is universally known to the natives of India—'nag' (pronounced narg). It is probable that this information was conveyed by letter and that he mistook the 'g' for 'j'. *Naja*, and still less the *Naia* of some authors, have no meaning."

The two common Singhalese names for cobra are 'nāgayā' and 'naiā', or more correctly, 'nayā', and if, as Colonel Wall states, it is probable that Linnaeus's information was conveyed to him by letter and that he mistook a 'g' for a 'j', is it not equally probable either his correspondent considered 'j' and 'i' interchangeable, as has been customary, or that he actually wrote 'y', which Linnaeus mistook for 'j'?

'Naja' has certainly no meaning to a Singhalese, but 'naiā' or 'nayā' will make him jump.

W. V. D. PIERIS.

Coconut Research Scheme,
Lunuwila, Ceylon.

P. J. Kipp

THE description by the author of a recent communication[1] of the apparatus for the continuous generation of gases at the ordinary laboratory temperature as a 'kip' is almost an insult to the work and memory of P. J. Kipp[2]. This eminent Dutch chemist was born more than a hundred years ago at Delft, where he founded the well-known firm of P. J. Kipp and Sons to which many chemists and physicists have been, and hope to be again, indebted for beautifully made scientific apparatus. A representation of Kipp's apparatus is incorporated in the seal of the Dutch Chemical Society.

We have become accustomed to the abbreviation of the name of the familiar burner as a 'Bunsen' and we may speak of Kipp's apparatus as a 'Kipp', but I, for one, hope it will never be described again as a 'kip'.

C. S. GIBSON.

Chemistry Department,
Guy's Hospital Medical School,
(University of London),
London, S.E.1.

[1] Robertson, *Nature*, 155, 395 (1945).
[2] *Chem. and Ind.*, 5, 509 (1930).

SCIENTIFIC AND INDUSTRIAL RESEARCH IN AUSTRALIA

THE seventeenth annual report of the Council for Scientific and Industrial Research, Commonwealth of Australia*, covers the year ended June 30, 1943, in which the total expenditure of the Council was £541,283, of which £106,126 was contributed from sources other than the Commonwealth Treasury. A large part of the Council's activities is now devoted to the solution of problems arising out of the War and to assistance and advice to Government Departments and other institutions and organizations concerned with the war effort, particularly the work of the National Standards Laboratory and the Departments of Aeronautics, Forest Products and Industrial Chemistry. Reference to these activities in the report is either confined to brief general statements or entirely omitted.

The work of the Division of Plant Industry followed the lines of last year. The Division continued to prosecute investigations leading to the production of essential drug plants, including those on poppy, pyrethrum, cinchona, *Duboisia* and *Ephedra*. In this work the Medical Equipment Control Committee of the National Health and Medical Research Council, the Department of Pharmacy, University of Sydney, the Physiology Department of the University of Melbourne, and the Forestry Department of Queensland are co-operating. Special attention is being paid to studies of plants likely to serve as a source of rubber, particularly to guayule and *Taraxacum koksaghyz*. Work is being continued on microbiological retting of flax, with some interesting results which may have an important bearing on the process. In spite of great difficulties owing to the shortage of seed and increased requirements, the Commonwealth Vegetable Seeds Committee set up in January 1942 operated under the chairmanship of the chief of the Division until January 1943, and the foundations have been laid for the development of a permanent industry.

Entomological investigations carried out for the medical branches of the Fighting Services have been very fruitful. Valuable practical results have come from the studies of the insect pests of stored wheat and wool. The work on insect pests of stored wheat has covered control measures in bulk depots, the fumigation of bag-sacks and the sterilization of stack sites. In testing some Australian nitrated cresols, it was found that mineral oil emulsion containing 5 per cent commercial grade dinitro-*o*-cresol was comparable in toxicity with the proprietary emulsion. Fumigation experiments have been carried on with the view of selecting material for use as sprays or solid fumigants against infested stacks of stored wool, and a nozzle has been designed which enables satisfactory distribution of liquid sprays to be obtained within a wool stack when used in conjunction with a jetting plant, and a technique for spraying stacks from above has been devised. The potato moth caused severe crop losses on the mainland during 1942–43, and experiments were carried out with a number of materials used as sprays for the control of potato larvæ in the haulms in the field, basic copper arsenate giving the most promising results.

In the field of animal health and nutrition more attention has been given to the immediate needs of the animal industry and to the application of existing knowledge to prevent waste. Investigations at the Animal Health Research Laboratory, Melbourne, have covered pleuropneumonia of cattle, mastitis in dairy cattle, contagious abortion, a study of the mechanics of hand-feeding sheep, and the toxicity of wheat for stock. The McMaster Animal Health Laboratory has continued its studies of phenothiazine in the control of nodulle worm and of the large stomach worm in sheep, as well as its work on dips and dipping. The study of the physical properties of wool has been interrupted, but in the field of wool biology further advance has been made towards establishing a method of analysis by which the main sources of biological variation within and between fleeces can be studied under well-controlled and uniform conditions. The Animal Nutrition Laboratory, Adelaide, has brought its investigations on energy metabolism of sheep to a stage ready for preparation for publication as a scientific monograph.

The work of the Division of Soils in the first half-year was largely concentrated on defence projects, and field surveys of laboratory research have been restricted through lack of staff. The main change has been the initiation of a programme of investigations in soil mechanics, principally concerning soil-cement, which it is proposed to continue as a major project. Investigations on the stabilization of soils with pure calcium chloride showed that dressings up to 6 lb. pure calcium chloride per square yard were insufficient to stabilize soils in inland southern Australia under concentrated traffic. The Commonwealth Research Station at Merbein, Victoria, was established primarily to investigate problems associated with the production and processing of dried fruit, including irrigation of the land and maintenance of soil fertility. Some of the investigations have been suspended during the last two years and replaced by investigations dealing with special war-time requirements, but the experience of the Station in primary production under irrigation conditions and in drying foodstuffs is being fully utilized by the Commonwealth Department dealing with the processing and storing of dried fruits and vegetables, and in the production of special crops not previously grown in commercial quantities in Australia. Fruit-drying investigations have now been extended to practically all dried fruits required by the supply authorities. The Station has assisted in the development of about 500 acres of land brought under irrigation since the outbreak of war. The plants grown include vegetables at military establishments, grass covers for aerodromes and drug plants. The Irrigation Research Station at Griffith, New South Wales, established in 1924, has been considerably expanded owing to pressing problems in maintaining the production of fruit and increasing that of vegetables. The long-term citrus cover-crop plants at the Station have demonstrated the value of lucerne in controlling excess soil moisture, salt and structure deterioration. Vegetable investigations have been concerned mainly with irrigation, the germination of seed, particularly of carrots, and weed control. The Station has also assisted in defining soil and slope suitability standards as a guide to the use of land for citrus.

The main activity of the Division of Forest Products has continued to be advisory work for the various branches of the Services and industry. Steady progress has been made in investigations basic to aircraft production, such as the development of improved wood and the use of timbers for aircraft plywood other than those already approved. Problems

* Seventeenth Annual Report of the Council for Scientific and Industrial Research, for the Year ended 30th June 1943. Pp. 76. (Canberra: Commonwealth Government Printer, 1944.) 3s. 4d.

arising out of the treatment of timber to fit it for use in tropical areas are under investigation. New laboratories have been erected for paper-testing work and for flax, but much experimental work is awaiting development in connexion with the newer types of synthetic resin glues and methods of plywood manufacture and use.

The work of the Division of Food Preservation and Transport has also been almost entirely devoted to problems of direct importance in the war effort. The canning and dehydration of foodstuffs continue to be the most important fields of investigation for the Division. The Meat Investigation Laboratory at Brisbane has been concerned chiefly with dehydrated beef, and the investigations have led to a closer definition of ideal processing conditions and may reduce processing costs. Particular attention has been given to the improvement of flavour. In work on storage it was observed that the dried meat is very subject to infestation by a beetle, *Dermestes vulpinus*. Other investigations have covered a survey of the vitamin C content of tomato varieties grown in the Bathurst district and of the vitamin C content during the processing of canned tomatoes, tomato juice and tomato puree. Meat-canning investigations have also assisted with production programmes, and container investigations have led to the development of technique and equipment for the rapid testing of cans. An attempt has been made to obtain fundamental data in this field, including studies of the effect of variations in tinplate thickness on closing-machine adjustments. Experiments to determine the storage life of different samples of dried egg under various conditions have continued, but the storage experiments on dried mutton have been completed. The Microbiological Section has been concerned almost entirely with canned foods and investigations on eggs. Fruit-storage investigations have included skin coatings on apples; the best results were obtained by hand dipping the apples in an alcoholic solution of 8 per cent castor oil and 2 per cent of de-waxed shellac. The treated fruit was less wilted, firmer, crisper and more juicy and the flavour and acid were retained longer. Wax emulsions are more effective than oil emulsions in retarding loss of moisture, but require higher concentrations and more alkaline soaps. The Fruit Products Section has been largely responsible for organizing the large-scale production in several States of canned and bottled citrus juices for antiscorbutic purposes in Service rations. The production of canned apple juice fortified with synthetic vitamins was also commenced in New South Wales and Tasmania, and research has been carried out on substitute containers, the smoke curing of fish, and electrical moisture meters.

The Fisheries Investigations Division carried out a comprehensive survey of the fishing industry for the man-power authorities, and technical work connected with the manufacture of agar was done in conjunction with various firms interested. An extensive survey of seaweeds suitable for this purpose is at present being carried out by the Division. A pilot plant for the manufacture of sodium alginate, potash and iodine is working in Sydney. Livers of twenty species of shark and ray have been examined for oil and vitamin content in an effort to find livers rich in vitamin A and possibly vitamin D to augment supplies being used in Victoria. The withdrawal of the research vessel *Warreen* from service during the year broke the continuity of the tuna observations on the south-east coast.

In the Industrial Chemistry Division, the Biochemistry Section continued research designed to assist the fellmongering industry, while the Minerals Section assisted in the commercial utilization of Australian minerals by devising and adopting chemical treatments necessary for the manufacture of a wide range of chemical compounds from crude ores and minerals; chromite, monazite, fluorite, bauxite, graphite, pyrolusite, rutile, beryl and rock phosphate received the main attention during the year. The whole of the research work in physical metallurgy of the Divisions of Industrial Chemistry and Aeronautics has now been consolidated in one Section of Physical Metallurgy, included for administrative purposes within the Division of Industrial Chemistry.

The Organic Chemistry Section has constructed and operated a pilot plant for the manufacture of ethylene. A pilot plant is also being constructed for the manufacture of ethylenechlorohydrin by a continuous process. Preliminary preparations of a synthetic rubber of the 'Thioplast' type have been made, and phenol and cresol-formaldehyde resins have been investigated to discover resins suitable for the production of compregnated woods and as hot glues for plywoods, compregnated woods, and wood-metal joints. A method of analysis developed in the laboratory gives valuable information when applied to resins of outside origin. Resins of the aniline/formaldehyde type are also being developed as moulding powders for some electrical work and as adhesives for compregnated woods. Surplus fatty acids have been examined as possible sources of substitute waxes, and a method of estimating the mannitol in the exudation from trees, *Myoporum platycarpum*, has been completed, and the isolation of the material on a pilot-plant scale is under investigation. The section concerned with lubricants and bearings have been engaged primarily on confidential war work.

The Information Section has made a distinct contribution to the war effort in the preparation of summaries and bibliographies connected with aspects of technical productions, and in the compilation of information on the substitution of Australian raw materials for materials formerly imported. Officers of the Section have continued to act as an abstracting panel for the preparation of *Australian Chemical Abstracts*, published by the Australian Chemical Institute, which are confined entirely to reports and articles published in Australia, and to Australian patents.

PENICILLIN TREATMENT OF VENEREAL DISEASE AND SPIROCHÆTAL INFECTIONS

THE remarkably successful treatment of gonorrhœa with penicillin was recorded in an earlier note on penicillin treatment (*Nature*, 677, Nov. 25, 1944). In that note also the opinion of United States Army medical men that the immediate effects of penicillin in the treatment of syphilis are better than those of arsenical preparations was recorded. Leading articles in the *Lancet* (853, Dec. 30, 1944) and the *British Medical Journal* (821, Dec. 23, 1944) discuss the whole question of penicillin treatment of human syphilis, with references to the relevant literature.

In the United States the first experiments on this problem were done on rabbits infected with syphilis, and J. F. Mahoney, R. C. Arnold and A. Harris

(*Ven. Dis. Inform.*, **24**, 355; 1943) were apparently the first to record penicillin treatment of human syphilis. In Britain, E. M. Lourie and H. O. J. Collier (*Ann. Trop. Med. and Parasitol.*, **37**, 200; 1943) showed that penicillin will cure infections of mice with *Treponema recurrentis* and *Spirillum minus*. In co-operation with A. O. F. Ross and R. B. Wilson (*Lancet*, 845, Dec. 30, 1944) they report on the treatment of five cases of human syphilis with penicillin. All these cases had well-marked secondary lesions, and the immediate response "could not have been bettered by any known form of treatment". The spirochætes and lesions disappeared at least as rapidly as they do under treatment with arsenicals and bismuth. But all these cases were in the secondary stage of the disease, and later observations upon them showed that only one of the five cases was apparently cured. It was therefore doubtful whether penicillin was as beneficial as arsenicals and bismuth would have been. These authors concluded that penicillin will not become suitable for routine civilian practice until frequently repeated day- and night-injections can be avoided.

The problem of dosage in the treatment of syphilis is discussed by both the *British Medical Journal* and the *Lancet* (*loc. cit.*). In the United States, where so much more penicillin is available, extensive trials of it for the treatment of syphilis have been going on at thirty-one centres, and the *Lancet* discusses the reports on these and the supply of penicillin, stating that, by April 1944, the tentative production programme of the United States and Canada was, according to R. D. Coghill (*Chem. Engineer. News*, **22**, 588; 1944), of the order of 200,000 mega units (1 mega unit is 1 million Oxford units). There will be general agreement that we are justified in expending a large proportion of even the limited British supplies of penicillin on the study of its effects on syphilis. Arsenical treatment is more toxic and is not infallible; it involves supervision of the patient for a year or longer, and J. Marshall (*Nature*, **153**, 187; 1944) has pointed out that less than half the patients get enough of such treatment to ensure a cure-rate of 80 per cent, because they default. One danger of future penicillin treatment is emphasized by both the *Lancet* and the *British Medical Journal* (*loc. cit.*). A patient may have both gonorrhœa and syphilis at the same time. The gonococcus is more susceptible to penicillin than the spirochæte of syphilis. Treatment with doses of penicillin which are sufficient to cure the gonorrhœa may therefore suppress the early signs of the syphilis, without being sufficient to cure this disease, especially if the syphilis is at an early stage when the only sign of it may be a hidden chancre. The diagnosis of syphilis may therefore be only made later when the secondary signs appear. F. L. Lydon and W. R. S. Cowe (*Brit. Med. J.*, 110, Jan. 27, 1945) also discuss this subject, adding the point that battle casualties treated with penicillin for gonorrhœa, for which it is, they agree, the drug of choice, may be incubating syphilis as well, which would thus escape detection. They think that routine blood-tests should be enforced by law upon the whole population. Similar cases of coincident infections with these two venereal diseases are discussed by F. A. Ellis (*J. Amer. Med. Assoc.*, **126**, 80; 1944) and by C. R. Wise and D. M. Spillsbury (*Brit. J. Surg.*, **32**, 214; 1944).

Penicillin seems to be very effective also against other spirochætes and their relatives. Brigadier G. M. Findlay, Major K. R. Hill and A. Macpherson (*Nature*, 795, Dec. 23, 1944) report some success in the treatment with penicillin of yaws, due to *Spirochæta pertenue* and of tropical ulcers infected with spirochætes, fusiform bacilli and other organisms. Ulcers have caused, during 1944, the loss of 30,000 men-days among West African troops. A. B. MacGregor and D. A. Long (*Brit. Med. J.*, 686, Nov. 25, 1944) report the rapid disappearance of *Treponema vincenti*, the cause of Vincent's gingivitis, under treatment with penicillin incorporated in pastilles. J. M. Alston and J. C. Broom (*Brit. Med. J.*, 718, Dec. 2, 1944) report on their experiments on its action on nine strains of *Leptospira icterohæmorrhagiæ*, the cause of Weil's disease (six strains were human, two were from rats and one from a dog) and on one strain of *L. canicola*, the cause of another form of leptospiral infection of man and dogs. Penicillin killed all these strains in cultures and also inhibited their multiplication. It also cured infections of guinea pigs with leptospira virulent to them, provided that it was given early enough (eighteen hours after infection). It did not prevent the development in the guinea pigs of serum antibodies or resistance to re-infection. It was not toxic to the guinea pigs as others have reported it to be. In the same issue of the *British Medical Journal* (p. 720), V. Lloyd Hart reports upon the treatment of one Italian male suffering from Weil's disease. The results suggest that even the very small doses, given at relatively long intervals, had some curative effect; but Hart also emphasizes the need for early administration. It is, however, difficult to diagnose Weil's disease in its early stages. The same necessity for early administration is emphasized by Brig. E. Bulmer (*Brit. Med. J.*, 113, Jan. 27, 1945) in his summary of the treatment by various medical officers of sixteen cases of the same disease in Normandy. It is thought that Weil's disease is spread by infected rats, which pass the spirochætes in their urine. The spirochætes can live for a time in stagnant water, wells and sewers, so that men infect themselves by drinking and bathing. Up to December 1944, cases had been notified between mid-July and the end of September, and only from Normandy. It is, Bulmer thinks, surprising that cases have not occurred in the Low Countries, where there is "plenty of water". There was great difficulty in assessing the results of the penicillin treatment. The liver and kidneys are rapidly damaged by the spirochæte, so that penicillin should ideally be given before the diagnosis can be made. Inadequate doses of penicillin appeared, however, to shorten the duration of the fever and to cause dramatic improvement, especially when high doses were given. It did not appear to influence the damage done to the liver and kidney. In the same issue of the *British Medical Journal* (p. 119), A. E. Carragher reports on the treatment of one other case, a soldier invalided from France. After only six injections of penicillin the *Leptospira* disappeared from the blood and there was rapid clinical improvement.

Among other organisms of the spirochæte type are *Streptobacillus moniliformis* and *Spirillum minus*, the causative organisms of the two rat-bite fevers. The reasons for the conclusions that two organisms are concerned in the etiology of this disease have been discussed (*Lancet*, 540, Oct. 21, 1944), together with the effect of penicillin on them. F. R. Heilman and W. E. Herrell (*Proc. Staff Meeting, Mayo Clinic*, **19**, 257; 1944) and H. Eagle and H. J. Magnuson (*Pub. Health Rep. Wash.*, **59**, 583; 1944) have confirmed the results obtained by Lourie and Collier mentioned above. Heilman and Herrell found that penicillin cured mouse infections with *Sp. minus* and *Strept. moniliformis*, so that both forms of rat-bite fever may prove susceptible to it. The former responds dramatically to organic arsenicals, but the latter resists arsenic, sulphonamides and gold treatment. F. F. Kane (*Lancet*, 548, Oct. 21, 1944) reports on the infection of an Ulster boy with *Strept. moniliformis* as the result of a rat-bite, which was successfully treated with penicillin after gold treatment had failed. Eagle and Magnuson obtained cures with penicillin of infections of rats and mice with *Spirochœta recurrentis* (=*Treponema novyi*), so that it is possible that penicillin may prove better than arsenic for the treatment of relapsing fever of man, which is caused by this organism. G. Lapage.

FORESTRY AND THE PUBLIC WELFARE

AT the autumn general meeting of the American Philosophical Society held in the hall of the Society on November 17–18, 1944, the first day was devoted to a symposium on "Forestry and the Public Welfare", brief papers being read (among others) on forests in relation to soils and water (Raphael Zon); world-wide needs of woods (W. C. Lowdermilk), public control of cutting practices on private timberland (Joseph F. Kaylor), and forest conservation—public and private co-operation (Wilson Compton).

Zon's research work in connexion with forests, soils and water is well known. He gave a brief summary of important points. The longer precipitation remains in circulation over the land before, as run-off, it reaches streams and ocean, the greater its use to the land. The greatest effect of forests upon water is therefore that they tend to prolong this water-cycle on and in the soil. In deep soils a large reservoir of ground water is retained which only gradually but regularly feeds the streams, thus preventing exceptional high rises resulting in floods, or low levels which diminish agricultural supplies. The protective cover of the forest reduces wind damage, decreases evaporation from the soil, reduces the temperature of the air and soil within the forest during the summer and raises it in winter. Growing trees transpire and thus increase the humidity of the air over forests, while their roots stabilize the soil.

Lowdermilk, in discussing the world-wide needs of woods, pointed out that man has grown up with wood, that he has always utilized the substance in the past, and human progress, in spite of the many substitutes, demands ever larger amounts. Wood, he said, is "a natural wonder of chemistry and physical structure"; but cellular structure and chemical content of cell cavities give rise to a wide variety and many properties that serve hundreds of uses, even to paper and clothing fabrics. Modern technology has by special treatment of impregnation and compression produced new materials from wood that compete with metals. Chemical industries are opening up amazing possibilities in deriving from wood as raw material new chemicals based on fermentation of carbohydrates, even to the making of alcohol for rubber manufacture. On the subjects of demand, Lowdermilk said that the production of wood, reported as some 1·2 billion tons, is second only to that of fossil carbonized wood as coal, namely, 1·3 billion tons, and is practically tenfold that of steel.

America has long halted at the cross-roads of State interference in any way with the operations of the lumberman; enormous areas have been felled without a thought to the future, while fire has destroyed additional large areas of virgin forest. In his paper on public control of private felling, Kaylor said that within the last few years sentiment in many parts of the United States has veered strongly towards some form of public control of private fellings, the cumulative results of the unrestricted cuttings of the past now being more fully realized. A difference of opinion exists as to whether such control should be exercised by the individual States or by the Federal Government. Kaylor spoke for Maryland, stating that in 1943 the legislature of the State passed the Forest Conservancy Districts Act authorizing a Commission of State Forests and Parks to draw up rules of forest practice for all the privately owned forests of the State—certainly a move in the right direction.

Dealing with public and private co-operation in forest conservation, Wilson Compton discussed briefly the exploitation of the forests in the past and the results of surveys of the forests still existing in parts of the United States and the work of conservation now being carried out. The surveys showed that there are nearly a thousand tree farms comprising 10 million acres in the western and southern States, and the number is being constantly added to. In 1941 the National Lumber Manufacturers' Association co-operated with the forestry departments of thirty-seven States in a survey of 153 million acres of privately owned timber lands—the so-called industrial forest lands; of these, 25 million acres were under working plans, 45 million under less intensive management, another 73 million acres with reasonably satisfactory reproduction, but not adequately protected from fire. In other words, about 94 per cent of the area surveyed was considered to be in a "reasonably productive condition". When the total disregard shown for the immense forest estate exploited by the United States for so long, as if it were inexhaustible, is remembered, it is a good augury that the lumber companies, and to some extent the private forest owner, should have realized where unchecked exploitation was leading the country and its important industries.

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Monday, April 16

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2). at 1.45 p.m.—Sir Frank Smith, G.C.B., G.B.E., F.R.S.: "Chemicals from Petroleum" (Cantor Lectures, 1).

Farmers' Club (at the Royal Empire Society, Craven Street, Strand, W.C.2), at 2.30 p.m.—Mr. H. W. Grimmitt: "Present and Future Aspects of Electricity in Agriculture".*

Association of Austrian Engineers, Chemists and Scientific Workers in Great Britain (Chemical Group) (at the Austrian Centre, 69 Eton Avenue, Hampstead, London, N.W.3), at 7.30 p.m.—Mr. E. Chilton: "Present-day Problems of Industrial Photography".

Royal Geographical Society (at Kensington Gore, South Kensington, London, S.W.7), at 8 p.m.—Dr. H. L. Richardson: "Szechwan during the War".

Tuesday, April 17

Institution of Naval Architects (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London. S.W.1), at 10.30 a.m.—Admiral of the Fleet the Rt. Hon. Lord Chatfield, G.C.B., O.M.: Presidential Address; Sir Amos L. Ayre, K.B.E.: "Merchant Shipbuilding during the War". At 4.30 p.m.—Mr. E. H. Watts: "Crews' Accommodation in Tramp Ships"; Mr. A. J. Sims: "The Habitability of Naval Ships under Wartime Conditions".

Royal Society of Arts (Dominions and Colonies Section) (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Dr. Charles Camsell: "The New Programme of Field Investigation in the Canadian North-West".

BRITISH SOCIETY FOR INTERNATIONAL BIBLIOGRAPHY (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 2.30 p.m.—Annual General Meeting; Presidential Address.

INSTITUTION OF ELECTRICAL ENGINEERS (RADIO SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Design of Broadcast and Television Receivers for the Post-War Market" (to be opened by Mr. L. H. Bedford).

Wednesday, April 18

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Sir Edward Appleton, K.C.B., F.R.S.: "The Work of the Department of Scientific and Industrial Research".

ROYAL SOCIETY OF MEDICINE (at 1 Wimpole Street, London, W.1), at 2.15 p.m.—Discussion on "The Control of Rickettsial Infections" (to be opened by Lieut.-Colonel C. H. Stuart-Harris, Dr. J. S. Carmichael and Dr. Raymond Lewthwaite).

INSTITUTION OF NAVAL ARCHITECTS (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 2.30 p.m.—Mr. W. Thomson: "Some Cases of Failure of Deck Plating due to Stranding"; Mr. W. I. Hay: "Some Notes on Ships' Structural Members"; Mr. J. M. Murray: "Notes on Deflected Plating in Compression and Tension". At 4.30 p.m.—Prof. T. H. Havelock, F.R.S.: "Notes on the Theory of Heaving and Pitching"; Mr. J. F. Allan: "The Stabilisation of Ships by Activated Fins".

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 3 p.m.—Scientific Papers.

INSTITUTE OF PETROLEUM (joint meeting with the BRITISH RHEOLOGISTS' CLUB) (in the Lecture Hall of the Royal Society of Tropical Medicine and Hygiene, 26 Portland Place, London, W.1), at 3.30 p.m.—Dr. A. Cameron: "Determination of the Pressure Viscosity Coefficient"; The Viscosity Panel: "Precision and Accuracy of Viscometry using B.S.I. Tubes"; Mr. E. R. Pethrick: "The Testing of Greases for Ball Bearings"; Mr. E. W. Hardiman and Dr. A. H. Nissan: "A Rational Basis for the Viscosity Index System"; Dr. A. Lahiri and Dr. E. W. J. Mardles: "The Problem of Engine Deposits"; Dr. A. S. C. Lawrence: "Lubricating Greases".

ROYAL METEOROLOGICAL SOCIETY (in the small Physics Lecture Theatre, Royal College of Science, Imperial Institute Road, South Kensington, London, S.W.7), at 4.30 p.m.—Mr. G. E. R. Deacon, F.R.S.: "Water Circulation and Surface Boundaries in the Oceans" (Symons Memorial Lecture).

ILLUMINATING ENGINEERING SOCIETY (at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 5.30 p.m.—Mr. R. Maxted and Mr. J. N. Hull: "Circuits for Discharge Lamps".

Thursday, April 19

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 11.30 a.m.—Annual General Meeting. At 2.30 p.m.—Prof. W. N. Haworth, F.R.S.: "Starch" (Presidential Address).

ELECTRICAL ASSOCIATION FOR WOMEN (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 2 p.m.—Twentieth Annual Conference.

INSTITUTION OF NAVAL ARCHITECTS (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 2.30 p.m.—Mr. T. C. Tobin: "The Dynamics of Launching"; Mr. E. O. Stephens: "Thames (Dumb) Barges". At 4.30 p.m.—Dr. G. Hughes: "On Singing Propellers"; Mr. V. D. Naylor: "The Concept of Pitch".

BRITISH INSTITUTE OF RADIOLOGY (in the Reid-Knox Hall, 32 Welbeck Street, London, W.1), at 8 p.m.—Prof. E. A. Owen: The Silvanus Thompson Memorial Lecture.

Friday, April 20

BRITISH INSTITUTE OF RADIOLOGY (in the Reid-Knox Hall, 32 Welbeck Street, London, W.1), at 4.45 p.m.—Dr. J. F. Brailsford: "Reflections in the Teaching of Radiology" (Mackenzie Davidson Memorial Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS (MEASUREMENTS SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Dr. L. Hartshorn and Mr. W. Wilson: "An Electrical Moisture Meter".

Saturday, April 21

SOCIETY OF INSTRUMENT TECHNOLOGY (at the London School of Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 11 a.m.

ASSOCIATION FOR SCIENTIFIC PHOTOGRAPHY (at Caxton Hall, Westminster, London, S.W.1), at 2.30 p.m.—Mr. E. Mackie: "A Consideration of the Requirements for Micrography and Cinemicrography Apparatus".

APPOINTMENTS VACANT

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

LECTURER (full-time) IN ELECTRICAL ENGINEERING—The Principal, Royal Technical College, Peel Park, Salford 5, Lancs. (April 21).

CHAIR OF PHILOSOPHY in the University of Otago, Dunedin—The High Commissioner for New Zealand, 415 Strand, London, W.C.2 (April 28).

LECTURER (woman) IN ZOOLOGY—The Principal, Royal Holloway College, Englefield Green, Surrey (April 28).

ASSISTANT LECTURER (temporary) IN MATHEMATICS—The Registrar, University College, Exeter (April 28).

CHIEF ANALYTICAL CHEMIST in the Research Department of a well-known firm in the London area—The Ministry of Labour and National Service, Appointments Department, Central (T. and S.) Register, Room 5/17, Sardinia Street. Kingsway, London, W.C.2 (quoting Reference No. F.3673.XA) (April 28).

SCIENTIFIC OFFICER (CHEMIST, male) at the West Midlands Forensic Science Laboratory at Birmingham—The Ministry of Labour and National Service, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. F.3859.A) (April 30).

METALLURGIST in the Research Department of a large firm in Yorkshire—The Ministry of Labour and National Service, Appointments Department, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. F.2721.XA) (April 30).

HEADMASTER OF PERSE SCHOOL—The Clerk to the Governors, Montagu House, Sussex Street, Cambridge (endorsed 'Headmaster') (April 30).

SUPERINTENDENT in a Government establishment (candidates should be well qualified in CHEMISTRY or CHEMICAL ENGINEERING, and should have experience in the Manufacture of Explosives and also in the Development of Chemical Processes)—The Ministry of Labour and National Service, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. F.3886.A) (April 30).

LECTURER IN MATHEMATICS in the Brighton Technical College—The Education Officer, 54 Old Steine, Brighton (April 30).

LECTURER IN ELECTRICAL ENGINEERING, with qualifications in TELECOMMUNICATIONS and LIGHT-CURRENT ENGINEERING, particularly ELECTRONICS—The Clerk to the Governing Body, Battersea Polytechnic, Battersea, London, S.W.11 (May 2).

ASSISTANT LECTURER IN ZOOLOGY, with special qualifications in ENTOMOLOGY or HELMINTHOLOGY—The Secretary, West of Scotland Agricultural College, Blythswood Square, Glasgow (May 5).

GENERAL SECRETARY—The Honorary Secretaries, Chemical Society, Burlington House, Piccadilly, London, W.1 (May 15).

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

READER IN INDUSTRIAL HEALTH—The Secretary of University Court, The University, Glasgow (June 1).

SHILLITO READERSHIP IN ASSYRIOLOGY—The Registrar, University Registry, Oxford (June 9).

UNIVERSITY CHAIR OF BACTERIOLOGY tenable at University College Hospital Medical School—The Academic Registrar, University of London, c/o Richmond College, Richmond, Surrey (September 24).

ENGINEER to the Ipswich Dock Commission and the Harwich Harbour Conservancy Board—The Clerk and Solicitor to the Ipswich Dock Commission, Old Custom House, Ipswich.

LABORATORY ASSISTANT (man or woman, Grade I) IN THE DEPARTMENT OF ZOOLOGY—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1.

POSTS on the RESEARCH STAFF of the BRITISH COTTON INDUSTRY RESEARCH ASSOCIATION (candidates must possess at least a good Honours Degree and be trained in Chemistry, Physics, Engineering Physics or Mathematics)—The Director of Research, Shirley Institute, Didsbury, Manchester 20.

LECTURER IN METALLURGY in the Coventry Technical College—The Director of Education, Council House, Coventry.

LIBRARY ASSISTANT—The Institution of Automobile Engineers, Research Department, Great West Road, Brentford, Middlesex.

ASSISTANT SECRETARY (male)—The Secretary, Empire Cotton Growing Corporation, 37 Inner Park Road, Wimbledon, London, S.W.19.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Eire: Roinn Talmhaiochta (Department of Agriculture): Brainse Iascaigh (Fisheries Branch). Statistics of Salmon, Sea Trout and Eels captured during each of the Years 1943, 1941, 1939, 1937, 1935, 1933, 1931, 1929 and 1927. (P. No. 6745.) Pp. 20. (Dublin: Stationery Office, 1945.) 6*d*. [63

The Knights of St. George, a Scout Movement for Men and Women: an Educational Scheme to make Peace more Glorious than War. By W. Margrie. Pp. 32. (London: The Author, 9 Tyrrell Road, S.E.22, 1945.) 1*s*. [63

Quarterly Journal of the Royal Meteorological Society. Supplement to Vol. 71, 1945: Report on the Phenological Observations in the British Isles from December 1943 to November 1944. By Major H. C. Gunton. Pp. 32. (London: Royal Meteorological Society, 1945.) 3*s*. [63

The Content of the Science Curriculum in Post-Primary Schools. Interim Report of a Sub-Committee of the Essex Science Teachers' Association. Pp. ii+14. (Chelmsford: Mid-Essex Technical College, 1944.) 6*d*. [63

Other Countries

Astrographic Catalogue 1900·0. Sydney Section, Dec. −51° to −65°. from Photographs taken at the Sydney Observatory, New South Wales, Australia. Vol. 17 (with Plate Constants for Vols. 13 to 16): R.A. 0^h to 6^h, Dec. −55° to −57°, Plate Centres Dec. −56°. Pp. vi+24. Vol. 19: R.A. 12^h to 18^h, Dec. −55° to −57°, Plate Centres Dec. −56°. Pp. ii+70. (Sydney: Government Printer, 1943–1944.) [272

Solcoronas Hydromekanik og dennes Forhold til Uroen på Solen og Solpletterne. Av K. G. Meldahl. Pp. 16+17 plates. (Stockholm: A.-B. Nordiska Bokhandeln Forlag, 1945.) [272

University of Bombay: Department of Chemical Technology. Annual Report 1943–44. Pp. iv+28. (Bombay: The University, 1944.) [13

U.S. Office of Education: Federal Security Agency. Vocational Division Bulletin No. 228 (Vocational-Technical Training Series No. 1): Vocational-Technical Training for Industrial Occupations. Report of the Consulting Committee on Vocational-Technical Training appointed by the U.S. Commissioner of Education. Pp. xxii+306. (Washington, D.C.: Government Printing Office, 1944.) 40 cents. [63