NATURE

No. 3779 SATURDAY, APRIL 4, 1942 Vol. 149

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., Three Gables, London Road, Merstham, Surrey
Telephone: Merstham 316

The annual subscription rate is £4 10 0, payable in advance, Inland or Abroad

Registered as a Newspaper at the General Post Office

COLONIAL DEVELOPMENT AND RECONSTRUCTION

THE importance of colonial development in relation to post-war reconstruction and Anglo-American co-operation has been widely recognized in several measures that have already been taken in furtherance of the new policy of colonial development and welfare outlined in the White Paper of February 1940, such as the establishment of the Leith-Ross Bureau and of the Hailey Committee. Lord Moyne has already been able to give an encouraging account of colonial development during the War, and in debates in Parliament dealing with labour questions and colonial welfare generally, suggestions for the further improvement of colonial administration, for example, by the appointment of a Standing Joint Committee of both Houses of Parliament, have been from time to time advanced. The International Labour Organisation devoted some attention at its conference in New York last October to labour problems in the Colonial Empire, and the place of colonial administration in Anglo-American policy was fully recognized before Japan launched her attack.

The recent reverses in the Far East have, however, brought colonial policy and administration into the forefront for urgent examination and drastic action.

The broadsheet on the "Future of the Colonies", which was issued early this year by Political and Economic Planning (P E P), is a suitable starting-point for the re-examination now demanded. The position in the south-western Pacific is only a special example of the general problem of colonial development, and a sound judgment on whatever mistakes in policy or administration may have been made in British Malaya cannot be reached apart from the broad background. Much of the defence and attack upon colonial administration in that area which have been developed seem to betray little sense of perspective, and to be unrelated to that broad strategic policy which is required both as part of our war effort and to implement the conceptions embodied in the Atlantic Charter. Five of the eight points of that Charter are directly relevant to the future of the Colonies, and while any elaboration of policies based on those generalizations presupposes the establishment of a durable peace and the creation of new international institutions, based on political realities, the initiation of such new forms of international co-operation is an indispensable part of the measures required to retrieve the position in the Far East.

In the development of tropical dependencies two problems are entangled : the need for development and the politically dependent status of the great majority of such dependencies. Both problems are resultants of their backwardness, cultural and economic, relative to the metropolitan countries, which has led to their being taken over as colonies by the more advanced nations. In considering the future of these areas, political, economic and social questions demand answers, and the fundamental problem is that of determining the relative emphasis and the desirable rate of change. We must determine not only the direction but also the tempo of advance.

Politically, we must first determine how far international regulation can be substituted for national possession, and, secondly, how best a movement towards responsible self-government can be encouraged. Economically, we must answer the questions how these areas can be developed so as to make their resources available to the rest of the world, and how the standard of living of the native peoples can be raised to enable them to play their part as markets for the products of other areas. Socially, we must determine first how to improve the health, the general relation of the individual to society, and the education and cultural development of native peoples, and secondly how Western techniques and ideas can be grafted on to an indigenous basis to secure social and cultural progress instead of disrupting native life.

Not only is it essential in tropical areas to discover the desirable rate of change, so that changes in one field may keep in step with other types of change, and assimilation and adjustment are possible, but it must also be remembered that such countries are only partly organized on a money economy basis, and most of their inhabitants have very low standards of life. Only where mineral resources are present have large financial returns in general been obtained, and many of these go directly to the metropolitan country. Disease, death-rates and the low educational level are other handicaps, and contribute to the persistence of backwardness, which is essentially a temporary phenomenon and should be regarded as an early stage in a far-reaching process of development, among the goals of which must be envisaged a high standard of life as well as self-government.

In regard to the political problem, it should be remembered that the foundations of European power in these areas were not in general laid by the deliberate action of Governments, but by the non-political action of traders. None the less, Colonies have always been a source of international friction, and, indeed, a special case of the friction between independent sovereign States of the modern type. Colonial friction cannot be abolished by any isolated treatment. As Schwarzenberger shows in his study of "Power Politics", Colonies form a special aspect of the relations of power and politics. The absence of a satisfactory moral basis for a dependent colonial empire, apart from the internal problem of meeting local aspirations for further self government, would alone enforce the need, as part of a real world settlement, of developing a colonial system designed to eliminate the jealousies of the industrially advanced nations, to promote the development of tropical areas in the interests primarily of their own populations but also of the rest of the world, and to facilitate their progress towards self-government.

Of the concrete proposals towards that end, the P E P broadsheet dismisses as unsatisfactory the pooling of all Colonies under an international administration.

It is urged that the solution of the problem lies in the whole-hearted adoption by the colonial Powers of the principle of trusteeship, with all its positive and practical implications, including that of some degree of international supervision and regulation of colonial affairs. Implementing the trusteeship principle by practical schemes for economic and social development would remove the sources of political friction between the colonial and non-colonial Powers. The Colonial Development and Welfare Act of 1940 is, of course, a definite step in this direction, but large-scale international co-operation of various kinds will also be required, and other backward tropical areas, besides the Colonies in the strict sense, must be included in such schemes of combined social and economic development.

As further steps to abolish friction about the Colonies, and to promote greater uniformity in social and administrative standards in colonial areas, as well as to accelerate progress towards self-government and property, the broadsheet visualizes an extension of the mandate system into an international organization with an executive council, a reasonable central fund at its disposal, and an expert staff trained in an international staff college. Administration would remain in the hands of the existing colonial Powers, but a small proportion of technical posts should be thrown open at once to qualified men of any nationality, the selection to remain in the hands of the existing Power. This proportion should be gradually increased, and the process might be extended to administrative posts as men trained in the colonial section of the international staff college began to be available.

In addition, there must be guidance and supervision on the international level, and to secure international agreement on the interpretation of the trusteeship principle itself the promulgation of a Colonial Charter is suggested. This need affirm only the following points: (1) colonial dependencies are held in trust; (2) the primary aim of the trusteeship is to enable the dependencies to attain self-government as rapidly as possible; (3) the second major aim is the development of colonial territories primarily for the benefit of their own inhabitants; (4) the trusteeship is exercised jointly by all countries included in the international organization, but delegated so far as administrative responsibilities go to Powers with colonial experience; (5) no inherent or permanent inequality exists between races or peoples, and equal status and equal opportunity for all is a goal to be realized as speedily as possible; (6) all nations adhering to the international organization shall have equality of opportunity in the Colonies, subject only to the need for maintaining efficient administration.

The raising of minimum towards optimum standards will be best achieved by a series of international conventions, to be in general the concern of the International Labour Office, which should be strengthened by the foundation of a special Colonial Section. The establishment of a Colonial Commission of the international organization to secure a combination of efficient planning, advice and grants in aid of development is suggested, and this Commission should be provided with a small but highly trained international staff of experts and advisers. What is immediately required is the encouragement of sturdy self-reliant local communities, with a liberal and increasing measure of self-government in economic

and political affairs. As Lord Hailey has emphasized, not only in his great "African Survey", but also more recently in speeches in Parliament and elsewhere, the most urgent practical problem is that of raising the economic and social level of life in colonial areas.

This clearly means a revolution in our whole thought and attitude to the Colonies. The shift in emphasis from political to economic and social progress means more than economic planning in the narrower sense, the diversification of tropical economics and the raising of income and standards of life. It means close attention to the human resources, and particularly, well thought-out schemes of health and education. The importance of education in the broad sense in mitigating the bad effects resulting from the impact of white civilization on backward culture is not easily overstressed. Extension of experiments now being carried on by the Arts and Crafts Department at Achimota on the Gold Coast would lead naturally to the establishment of schools of social and economic survey and research, which, besides canalizing the enthusiasm and intelligence of the native *élite* as they become sufficiently trained, would provide, by carrying out field experiments, social and agricultural, a basis for the orderly development of social policy. Integration of higher education, including research, in European countries with that in the Colonies through large-scale interchange of personnel at various grades would be of particular value in preventing isolation and stagnation in the Colonies, and in stimulating interest at home in colonial problems.

The methods to be employed in furthering the general economic aim, however, must conform to three general principles. Each area should earn as much as possible towards building up its own essential services. Secondly, the maintenance of a proper standard of living should never be left at the mercy of local commercial interests or of the stresses and strains of world economic forces; a basic minimum standard should be guaranteed, however long it may be before the area can be developed to become self-supporting. Thirdly, all external commercial enterprise must operate to the benefit of the local population.

As to the machinery of tropical development, the broadsheet suggests that a Colonial Investment Board should be attached to the International Colonial Commission to influence and guide private finance into the channels most suitable for achieving colonial development. In addition to Government administration, co-operative producer agencies, such as the Empire Cotton Growing Corporation in the Sudan, and marketing agencies associated with international control schemes which already function, two further types of large-scale development agencies are envisaged: international public concerns, operating for profit under licence, and regional development agencies, not operating for profit. The former might be started where a local surplus is available and can find an external market, and it might take various patterns subject to welfare and conservation regulations approved by the Colonial Commission and to limitations on profits.

Regional development agencies, on the other hand, will be required in those numerous regions which require large-scale development before they attain a level of economic activity at which commercial profit can be expected. Their problem is as much social as economic, and involves the transformation of every aspect of life. When established they should be under international supervision, and apart from this their functions would closely resemble those of such a body as the Tennessee Valley Authority. Similarly, wherever one of the main products of a territory is controlled by an international commodity control scheme, a local producers' organization, with Government participation, will be required to represent the territory and to arrange for proper marketing facilities.

On the necessity of planning development in all backward areas on a long-term basis, to achieve smooth working, there can be no reasonable doubt, and the broadsheet equally endorses the "African Survey" in its insistence on the need for adequate survey and research as a pre-requisite to development in almost every field. Also it sees in the regional development of the equatorial territories of Belgium, Britain and Free France, Anglo-American co-operation in the Red Sea area and the Persian Gulf, and the Supply Councils for the Eastern Group, the Middle East and the Pacific Areas, a tendency towards the grouping of separate territories into larger units capable of supporting the expert staff required for such developments as are suggested. Besides this, it is essential that with the extension of international co-operation, and the delegation of more power and responsibility to administrators on the spot, the Colonial Office must include a section for the framing of broad policy.

It is no disparagement of British colonial achievements in the past or of the new policy represented by the White Paper of February 1940, to suggest that one good result of the defeats in Malaya and Burma may be a greater readiness to recognize that in the field of colonial policy and administration Great Britain has much to learn from the experience of others in the same field, and that in the pooling of experience the contributions will come not from one side alone. The breakdown of any such reserve is essential in the pooling of ideas, in participation in joint regional schemes, in projects for survey and research, in association on the International Colonial Commission and other ways by which the colonial Powers could rapidly establish a common policy of material, political and cultural development.

The bitter experiences of the East Indies may indeed result, not in useless recrimination or invidious comparison between Dutch and British practice, but in a close contact and pooling of experience which will enable us to construct a new regional order. Already there are signs that the Colonial Office is alive to many of the issues involved. The memorandum submitted to the International Labour Conference, Major Orde Browne's report on labour conditions in West Africa, the establishment of a special department on Labour and Welfare, and of a Labour Advisory Committee, are all indications of a new outlook and a greater readiness to learn from the

experience of others, whatever doubts may sometimes be entertained as to the extent to which the new outlook has found expression in the field. Moreover, this is not a matter which is the concern of Great Britain alone. Apart from the great help which the United States can undoubtedly give generally, particularly in such areas as the West Indies, to implement a far-reaching constructive colonial policy, the co-operation of the British Dominions is also essential.

The problems of the Colonial Empire were discussed in two articles in *The Times* of March 13 and 14 by Miss Margery Perham. It is impossible to summarize them here; they should be read and studied carefully. Some points she raises have been taken up in correspondence by Dr. Raymond Firth and by Lord Moyne. Dr. Firth points out that for more than a decade anthropologists, educationists, historians and others have been amassing data relating to the Colonies, and that they have stressed the bad effects of labour migration, the economic difficulties of the native peasantry and the lack of educational opportunities. He envisages more adequate training of administrators, whether native or white, in economics and other social studies, recognition of the importance of science in coping with all aspects of colonial life, and wider understanding of colonial questions by the people of Great Britain. Lord Moyne discusses in particular the financial disadvantages under which colonial administration has functioned, condemning in particular the system whereby the white officials are, in effect, dependent on local budgets for salaries and pensions, so that the poorer Colonies, which need the ablest men, are automatically unable to employ them.

The dominant need at the present moment is for the examination of policy and administration in the remaining Colonies and Dependencies with the determination to eradicate swiftly and ruthlessly any mistakes or weaknesses revealed in the light of recent experience. We must also initiate without delay whatever measures may be required to capitalize their good will and moral as well as material resources in the service of freedom, and in the furtherance of a colonial policy designed to eliminate friction between the great Powers over colonial questions and enable each major colonial region to develop its own culture with the assistance of the science and thought of the Western Powers. If we can bring to this task the necessary magnanimity, vigour of mind, vision and firmness of purpose, we shall find that once again our policy and its execution serve both the immediate war needs and the furtherance of those changes designed to secure an enduring peace. Nor should it be forgotten that the achievement of such aims and the removal of the frustration which is the key-note of the dissatisfaction felt in the Colonies to-day, both by the advanced minorities and by recruits in the colonial service, involves a much wider and intelligent interest in colonial affairs by the people in Great Britain. Scientific workers who, as Lord Hailey's great survey has shown, have so large a part to play in colonial development, must not be backward in the work of educating public opinion that is involved.

THE THREE NEGATIVES OF THERMODYNAMICS

The Nature of Thermodynamics

By Prof. P. W. Bridgman. Pp. xii+229. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1941). 20*s*. net.

THE position of author and reader in this challenging book are those of two students of thermodynamics who have mastered conventional thermodynamics, and, having attained some degree of maturity in applying it, agree to confide in one another their various doubts and difficulties. In a pleasantly informal way, Prof. Bridgman discusses a variety of situations to which the easy application of thermodynamic reasoning is far from obvious; and the reader *may* end by becoming a sceptic. Nevertheless, the broad principles of thermodynamics emerge from their ordeal, on the whole, better than one feared. The attitude of the book is the reverse of complacency; it never says "physics teaches . . .", and it will have done good in showing that orthodox positions are never incapable of criticism.

The author's general purpose is the attainment of "understanding", and with this object he rejects any precise, logical, postulational formalism in favour of discursive argument. His topics are the three primary concepts: temperature, energy and entropy. But his procedure is not to treat them as indefinable concepts (cf. Bryan's treatment of energy in his famous "Article"), but to apply always the 'operational' method, that method which consists in defining quantities only through the material processes by which they can be measured. The method in effect originated in the British school of philosophy of Locke and Hume, but in modern days takes its inspiration from Einstein, who applied it with such brilliant success to the previously undefined concept of simultaneity. It has been developed at length by Prof. Bridgman in an earlier work.

The three thermodynamic notions above-mentioned are connected with three well-known negative statements of operational character—"postulates of impotence" as E. T. Whittaker has recently called them. Temperature is connected with the *inaccessibility* of certain states of a body from other states as a starting point, when the body is adiabatically enclosed. Energy and entropy are connected with the *impossibility* of constructing certain types of 'perpetual motion' machines. From these statements, the concept of a measure of temperature and the two laws of thermodynamics may be isolated. Prof. Bridgman truly remarks, in this connexion, that thermodynamics smells of its human origin: adiabatically walled bodies, and heat-engines, are constructions that do not "occur in nature", any more than the triangles of geometry. They are none the less proper subject-matter for theoretical physics.

Prof. Bridgman's operational method as regards temperature is akin to the above negative postulate. He shows that a variable (the "temperature on an empirical scale") is necessary to complete the description of the state of a body in addition to a set of independent mechanical variables equal in number to the degrees of freedom possessed by the body when in 'thermal' equilibrium with a given large body. The author says much to clarify the foregoing rough paraphrase, since the 'thermal' in thermal equilibrium needs explanation, and moreover we eventually use some *mechanical* variable such as length or volume to

measure temperature. I am scarcely convinced that a 'heat-blind' person would gain a clear picture of temperature from Prof. Bridgman's account; but probably this would require that postulational treatment which the author is at pains to avoid.

With regard to the next negative, it is remarkable that Prof. Bridgman scarcely mentions the question of what is meant by the 'mechanical equivalent of heat'. We cannot test the First Law by means of the author's "surface sentries", until we have a value for J; yet we apparently cannot determine J without assuming the truth of the First Law. It is from the *proportionality*, of course, of heat gained to work lost that the idea of conservation of energy originates. But the author never says so. Instead, he spends much time on the hypostatization of energy, a tendency which I can only deplore. The author seems (in spite of disclaimers) to regard energy as having traceable identity: if it disappears at A, and appears at B, he is anxious to locate it on its way from A to B, and he therefore attempts to measure its *flux*, and to resolve the latter into a density and a velocity. One feels that Prof. Bridgman's engaging illustrations—the problems of the bent bar in motion (p. 45), of the moving rough block (p. 48) and of the gravitationally attracting spheres which are held apart by rigid connexions during their displacement (p. 107)—involve difficulties only because he insists on hypostatizing energy. Actually we know nothing of energy directly. To the operational method, energy is only known through performance of mechanical work (a more elementary notion than energy): when we perform work, either we create heat or we store up the power of securing work to be done for us in future, and thermodynamics gives the name energy to a certain linear function of the two which remains constant. The author appears to forsake the principles he is expounding when elaborating his ideas of energy-flow. He hypostatizes entropy similarly in its turn, but here the boot of criticism finds itself on its proper leg, for the student's usual difficulty is to think of entropy as a *thing* at all.

Prof. Bridgman repeatedly returns to the question of whether the macroscopic methods of thermodynamics or the microscopic methods of statistical mechanics are the more fundamental. He points out that all the basic microscopic variables are defined in terms of operations the practicability of which is derived from our large-scale experiences. He concludes that logically the thermodynamic method is the more fundamental. "The complete confidence of most physicists in their atomic analysis . . . overlooks the essential fact that logically the microscopic has its origin in the macroscopic. Any suspicion of the adequacy of our macroscopic analysis should at once arouse suspicion that our microscopic analysis is also inadequate." This is well said; in physics, to be iconoclastic of the macroscopic is to be defeatist. It may be mentioned that Prof. Bridgman is extremely happy in his account of the deficiencies of Maxwell's demon.

In conclusion, it may be remarked that the laws of thermodynamics are not to be confused with the aphorisms in which they are sometimes supposed to be expressed. To say that the energy of the universe is constant, or that its entropy increases, are operationally meaningless phrases. We can only speak of the energy of the universe at an instant when we have set up a standard of simultaneity; as this universe of ours contains, apparently, *motion* on such a large scale, simultaneity in the large is a matter of convention and of the scale of time adopted; hence to add together the energies of the separate parts of the universe at chosen instants is a purely conventional process; moreover, the universe (in my opinion) is probably not finite in number of particles. The difficulties with regard to energy are accentuated if we try to speak of the entropy of the universe, for to show that it increases we should have to compare entropies at two separate 'instants', and the simultaneity trouble crops up again worse than ever. It must be said that Prof. Bridgman adopts an exceedingly naïve cosmology in discussing the energy and entropy of the whole universe. Nevertheless, it is pleasing to find that he insists that before one can even attempt to speak of the energy of the universe, it is necessary to contemplate the separation of the universe into at least two parts, one of which contains the observer and his apparatus, and the other is the seat of possible energy transformations. I rejoice in this for the personal reason that some years ago I was castigated by a referee for pointing out a similar situation with regard to entropy: to measure the entropy change consequent on an 'irreversible' process, it is necessary to undo the process *reversibly* by heat transfers to and from a portion of the universe *external* to the seat of the irreversible process in question. Operational tests of the famous energy and entropy aphorisms of Clausius are thus most awkward. Prof. Bridgman's exposures of all the far-flung consequences of the operational method are highly stimulating.

E. A. MILNE

THE RANDOM ELEMENT IN TIME SERIES

The Variate Difference Method

By Gerhard Tintner. (Cowles Commission for Research in Economics, Monograph No. 5.) Pp. xiv + 175. (Bloomington, Ind.: The Principia Press, Inc., 1940.) 2.50 dollars.

NEARLY all time series, whether possessing trend or not, exhibit fluctuations of a more or less irregular kind. One of the first questions to be considered in analysing such series is how much of the fluctuation can be ascribed to purely random effects —random in the particular and important sense that a value at one point is independent of values at other points in the series. From the very nature of random variation it is impossible to calculate the random component at every point, except in the form of a residual which is left over when the systematic element has been abstracted; but it is possible to estimate the variance of the random element for the whole series on certain broad and plausible assumptions.

If a time series is differenced k times, the variance of the random element in the resultant series increases rapidly, being $(2k\,!)/(k\,!)^2$ times that of the original. On the other hand, the systematic element is reduced, or at least does not increase to the same extent, unless it is of very short period. If, therefore, a given series is differenced, and its variance divided by the factor $(2k\,!)/(k\,!)^2$, the result should tend to the variance of the random part of the original series. The elimination of systematic effects by differencing is the basic idea around which the theory of the variate difference method is built.

The method appears to have been used for the first time by Poynting in 1884 in a study of the relation-

ship between wheat prices and silk—and cotton—imports into the United Kingdom. Since that time it has engaged the attention of many writers, not always favourably, and the mathematics of the subject have been worked out very fully by Prof. Oskar Anderson, whose treatment is followed by Prof. Tintner fairly closely.

This book is an excellent account of the whole subject and can be thoroughly recommended. Tintner explains the technique of the variate difference method in great detail but has relegated mathematics to notes and appendixes, with the result that the non-mathematical reader can assimilate and apply the method without being bothered by theoretical detail, but on the other hand with a full understanding of what he is doing.

There is one important point arising out of the interpretation of results given by the method which one would like to have seen brought into greater prominence. In economic time series the random variance is often found to be a surprisingly small proportion of the total variance of the series, frequently only about 10 per cent and sometimes as low as 5 per cent. The natural inference would be that the remaining 90 or 95 per cent is systematic and hence may be predictable. But this is not necessarily so. The variance shown as 'random' by the variate difference method is attributable only to effects, comparable to errors of observation, which do not lag from one year to another. An economic disturbance may be random in the sense that it is casual and unpredictable, but once it has occurred it may affect subsequent years, and if it does the variations in successive years are no longer independent. The result may be either to increase or to decrease the variance given by the variate difference method. This type of correlation between successive years is not uncommon and is an overriding difficulty in the interpretation of the results given by variate-differences. There are other points which have led authorities such as Udny Yule, Bowley and Persons to doubt the usefulness of the method; but Prof. Tintner gives full references to these criticisms, and his exposition of the subject is well worth a careful reading by anyone interested in the baffling subject of time series.

M. G. KENDALL.

MIDDLESEX PLACE-NAMES

The Place-Names of Middlesex, apart from the City of London

By J. E. B. Gover, Allen Mawer and F. M. Stenton, with the collaboration of S. J. Madge. (English Place-Name Society, Vol. 18.) Pp. xxxiv+238. (Cambridge: At the University Press, 1942.) 18*s*. net.

THE appearance of another volume of the English Place-Name Society is at all times welcome, but in these days more so than usual. The book, but for special difficulties easy to be imagined, would have dealt not only with the County of Middlesex, but also with the City of London. With regard to the latter some of the necessary unprinted sources had become unavailable, and not everything which the editors desired in the case of Middlesex could be produced from "places of safety". Add to this that the invaluable help of Prof. Ekwall, through the exigencies of war, was lacking, and it will be seen that certain additions to what is now published may possibly be forthcoming in due time. But when all is said, the book is a mine of information, and is written with the trained judgment and precise scholarship which the names of its editors and compilers guarantee to us. A most essential point; for the study of place-names has a fatal fascination for the man in the street; he rushes in where the learned will suspend judgment, and their cautious approach to such household words as Piccadilly, Pimlico and Soho is rather in the nature of a red rag to him.

The name of Middlesex—the province of the Middle Saxons—is somewhat of a disappointment in itself, implying a much more important territory than the little county we know, a county, moreover, which while witnessing to the early stages of the Saxon settlement never became prominent or produced any of the great men of the time. So that where Saxon personal names survive, as in Kensington, Islington or Ealing, we know nothing of Cynesinge, Gisla, or Gilla, nor are the more interesting survivals of tribal names much more enlightening. A thrill is, however, to be obtained from the cryptic Gumeninga Hergæ, preserving the memory of a heathen shrine where now stands that famous landmark the spire of the church of Harrow-on-the-Hill.

The general impression given is of a district of farmland and woodland, full of small settlements the owners' names of which, where early documents have come down to us, are to be verified now and again; but where no records earlier than the twelfth or thirteenth centuries exist, have been altered out of recognition, and can only be guessed at. The physical features of the district, which are not striking, account for another batch of place-names, and tend inevitably to repeat themselves, as in South African place-names, of to-day. There are obscurities here, as when names implying chalk, in a district where no chalk occurs, have to be considered, and the traditional derivation of Chelsea, as a "port where lime is landed", will not survive linguistic tests, and is here suggested to be due to "folk-etymology". Such popular explanations of place-names are disappointing, and instinctively avoided, as an easy way out, by the scholar. A later series of names, the origin of which is either humorous—as Eel-pie Island—or contemptuous—as the Isle of Dogs—come into the same unsatisfying category, and there is finally the list—only too long—of names for which no adequate explanation can be given. Among these it is sad to find that inevitable attraction, Cold Harbour, here dismissed as "of no particular archæological significance"—almost as much of a shock to the interested public as is the Charing of Charing-Cross, which long precedes Queen Eleanor, and refers to the bend which the river takes at this point. Nor can we do other than regret that Horace Walpole's Strawberry Hill, so redolent of its period, must own its descent from a house built by a retired coachman and dubbed by his candid friends Chopped Straw Hall.

The lists of street names given under districts rest on a much firmer footing, as is natural, and are invaluable as a record of recent development, the memory of which soon fades.

The book ends with a list of the elements, apart from personal names, found in Middlesex place-names. Only four of these, all river names, come down from the times before the Saxon invasions, and at the other end of the story are three of French origin. There follows a list of Saxon personal names, and a solitary Scandinavian; then field and minor names, and an appendix on Saxon charters of Hendon, Hampstead and Westminster. Once more, a mine of information.

CHARLES PEERS.

Statistical Dictionary of Terms and Symbols

By Dr. Albert K. Kurtz and Dr. Harold A. Edgerton. Pp. xii+91. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1939.) 12*s*. net.

THE authors have collected their data from a number of current text-books and periodicals, and have been aided by an advisory council comprising some of the best-known American statisticians. Only definitions and occasional illustrative comments are given. This is in no sense a source book like Mulhall's famous "Dictionary of Statistics."

There is undoubtedly scope for a book of this kind, if only to help in standardizing nomenclature. Indeed, one of the most striking things brought out by the present work is the variety of names applied to the simplest statistical concepts. No fewer than eighteen synonymous terms are given for the normal distribution. For the figure known to English statisticians as the "scatter diagram" there are a dozen equivalent terms of varying degrees of cacophony, etymological impurity and sheer inaccuracy, such as "scatterplot", "scattergraph" and "double frequency table". The authors have been very chary of exercising the lexicographic prerogative by condemning any of these expressions as bad usage.

There are errors of both commission and omission in this book. The Gram-Charlier Type B series (p. 70) is not the same as the Poisson series; Bayes' principle (p. 16) is not the same as Bayes' theorem; the tetrachoric functions (p. 176) are not the same, except for sign, as Hermite's polynomials (which, by the way, are due to Tchebycheff, not to Hermite); the function usually denoted by t is not the ratio of a statistic to its standard error (p. 174). Of the five definitions of "error" on page 56 the first is "the observed value of a variable minus the true value. Not to be confused with deviation from the mean", and the fifth is "same as deviation from the mean". No doubt both usages exist, but the caution against confusion reads rather oddly. Among the omissions may be noted the absence of definitions of serial correlation, distributed lags, orthogonal polynomials, conditional statistics, Latin squares, random sampling numbers, divided differences, Edgeworth's translated frequency curves, cumulants and characteristic functions.

A dictionary of this kind will be generally useful and it is to be hoped that subsequent editions will see the incorporation of the many improvements which are possible.

M. G. KENDALL.

In Search of Northern Birds

By Seton Gordon. Pp. 224+16 plates. (London: Eyre and Spottiswoode (Publishers), Ltd., 1941.) 15*s*. net.

SETON GORDON has again recaptured the air and charm of the lonely hills and islands of the north, and in his usual inimitable style. Few naturalists have described these solitudes so often and so pleasantly. The descriptions of well-loved hills and islands are interspersed with observations on birds and beasts and flowers.

It is a wide range that Seton Gordon embraces in his search of these fastnesses, and his notes on winter-day wanderings have perhaps a special value to most of us who only know these places in summer. He takes us from Lambay Island (Rechru) in the Irish Sea, and from the Pembrokeshire Islands, through the Hebrides (with a note on the little Northumbrian Island of Coquet) as far north as Iceland. On the north coast of Iceland, near Akureyri, he saw birches twenty feet high. At Lake Myvatn the flies drive even the hardiest fisherman to abandon the splendid trout-fishing. In the Westmann Islands he reminds us of the gannet colony at Sulnasker, and we can add that we have seen gannetries also on the neighbouring islets of Geldungur, Hellisey and Brandur, making a pretty large colony of probably four thousand breeding pairs.

Back in the Cairngorms, Seton Gordon asks how is it that moss can survive under snow for perhaps more than a year. He tells us that at the present day the marten still survives in the far north-west of Scotland, while the wild cat is not in danger of extermination.

R. M. L.

Electric Power Stations

By T. H. Carr. Vol. 2. Pp. xv+440. (London: Chapman and Hall, Ltd., 1941.) 32*s*. net.

THIS book, which deals with the electrical equipment of power station plant, is a companion volume to the author's earlier work on the mechanical side of the subject, and the two together constitute a very informative survey of modern station practice. The subject arrangement of the present volume betokens the authority with which the author writes and it covers alternators, condensing plant, feed-heating and water-treatment plant, transformers and reactors, switchgear, cabling and cables, oils, station auxiliaries, electrical protective equipment, station lighting, commissioning and testing of plant, station organization, station costs, and fire fighting and A.R.P.

Broadly, the book embraces considerations of design, construction and operation, and it contains numerous line and half-tone illustrations and detailed calculations where desirable. Many tables are included and a bibliography is given at the end of each chapter to facilitate further study.

As Sir Leonard Pearce says in his foreword, the book will be valuable in enabling specialists to keep contact with branches of engineering other than their own.

Algebraic Solid Geometry

An Introduction. By S. L. Green. Pp. vii+133. (Cambridge: At the University Press, 1941.) 6*s*. net.

THIS little book, based on courses of lectures given to students of Queen Mary College, London, may be regarded as an attempt to reduce the subject of algebraic solid geometry to a minimum. There are six chapters, dealing respectively with co-ordinates and direction-cosines, the plane and straight line, the sphere, the central quadrics, the paraboloids and the cone. The number of diagrams is only fourteen, which is scarcely sufficient. The second diagram has to serve for two different theorems, and does not show all the points mentioned in them. The examples include several from recent examination papers of the University of London. The general impression conveyed by the book is that the author's primary object was to make the subject as easy as possible, but that he has been handicapped in this by having to consider also the need for economy in paper.

POST-WAR AGRICULTURAL RECONSTRUCTION

By G. V. JACKS
Imperial Bureau of Soil Science

THE Division for the Social and International Relations of Science of the British Association held a Conference in London during March 20–21 to discuss problems connected with the post-war reconstruction of agriculture in Europe. Representatives of most of the occupied countries attended, and many addressed the Conference. A remarkable unanimity was evident in the diagnoses of the causes of pre-war agricultural troubles and in the formulation of the desiderata of reconstruction. All agreed that the best hopes for the future lie in the development of small-scale peasant farming concentrating primarily on livestock, fruit and vegetable production, this being a type of agriculture that would best serve to absorb the abundance of available labour, to raise national standards of living and of nutrition, and to enable European economy to play a more harmonious part than hitherto in world affairs.

At the first session, which was opened by Sir Richard Gregory, President of the Association, the need and aims of agricultural reconstruction were discussed. Sir John Russell, from the chair, said that one of the most immediate needs that will have to be satisfied is the provision of fresh seed and livestock for the devastated regions, and he suggested that schemes for collecting supplies should be initiated forthwith, particularly in North America, where the wide range of soils and climate enable all the kinds of seed required to be propagated. Sir John, like all the speakers, sees the best prospects for the successful rehabilitation of European agriculture in a greater production of 'protective' foodstuffs at the expense of cereals.

Mr. Kenneth Brooks gave an account of the European relief activities of the Society of Friends after the War of 1914–18. From the experience then gained he drew four main conclusions: (1) that it is impossible to separate relief from rehabilitation; (2) that short- and long-term policies in agriculture must be developed concurrently; (3) that international co-ordination of monetary and fiscal policy is essential; (4) that the quality of human sympathy in the administrative personel is at least as important as professional qualifications. A paper by Mr. Mikolajczyk, Deputy Prime Minister of Poland, indicated, by reference to present conditions in his country the immensity of the difficulties which will confront relief workers after the War.

Dr. B. Cubrilovič, approaching the subject from the economic point of view, maintained that a planned international economy with human welfare rather than profit as the objective must form the basis of any scheme of permanent reconstruction. Agriculture cannot be planned apart from industry, nor can a plan succeed which does not admit that the welfare of Germany is complementary to that of eastern Europe.

An account of predominantly small-scale farming in a densely populated country was given by M. L. Borremans, from Belgium. Under German occupation, grain production is being excessively stimulated at the expense of livestock and mixed farming. There will be urgent need after the War to restore the intensive production of protective foods and livestock, and to re-develop the processing industries.

At the second session a discussion on economic problems was opened from the chair by Mr. F. L. MacDougall, who referred to the work of the League of Nations Nutrition Committees, which are now taking up problems connected with post-war reconstruction. He feels that the basis of reconstruction should be the attainment of the four freedoms of the Atlantic Charter, and in particular freedom from want. The most serious nutritional deficiencies have occurred in those countries producing cereals for export. Post-war Europe will require an immense expansion of livestock farming; wines and fruit might advantageously replace wheat as the main export of south-eastern Europe. He thinks that a regional authority, on the lines of the Tennessee Valley Authority, operating independently of political boundaries and with wide powers to integrate riparian activities and co-ordinate them with other forms of production, might be set up in the Danube basin. But the basis of any such scheme must be adequate nutrition, the attainment of which is not precluded by any natural factor from any European country.

Dr. D. Mitrany advocated the cause of the peasantry against the views of the classical and Marxist economists, who affirm that the peasant is an anachronism, on the assumption that the basis of agricultural evolution must be a steadily increasing demand for wheat and other large-farm crops with the growth of industrialization. But since European wheat can never compete successfully with wheat grown extensively in the newer countries, emphasis in Europe is swinging from quantity to quality production, that is, to types of farming pre-eminently suited to peasant proprietorship, The Nazi aim of European self-sufficiency would mean the death of the peasant; the alternative—a higher nutritional standard and co-operation with overseas grain producers—could be achieved by a greater development of mixed peasant farming. Mr. N. Barou described the development of collective farming in the U.S.S.R., where the small private holdings held by the workers have been found to afford a necessary outlet for the individualism which is as characteristic of the collective farmer's nature as it is of that of the peasant.

Dr. R. Bičanič said that over-population of the land in eastern Europe has resulted in poverty, exploitation, excessive subdivision of holdings and consequent inability to effect any agricultural improvements. He believes the net effect of the War will be to increase over-population. Suggested remedies include the allocation of more land to the peasants and its more equitable distribution, intensification of mixed farming, the development of rural industries and the undertaking of public works on a large scale. There is need for great speed in making these changes, which will produce revolution unless they are made as part of a carefully planned economy within an international frame.

Mr. P. Lamartine Yates took Danish agriculture as an illustration of how a large population can be supported on naturally poor land at an exceptionally high standard of living. He associated Danish rural prosperity with the high proportion of intensively farmed arable land together with a livestock population much greater than could be fed off home-grown fodder, and in particular with the high level of education of the farmers. The advancement of agriculture in more backward countries depends as much on broadening the basis of education and

raising the standard of intelligence of the people as on any of the economic and agricultural remedies mentioned at the Conference.

The future betterment of European farming was discussed on the second day at sessions presided over by Mr. A. J. Drexel Biddle, the American Ambassador to the occupied countries, and by Sir John Russell.

Miss Margaret Digby recapitulated the causes of agricultural backwardness advanced by speakers on the previous day, and emphasized the military reasons for State policies aiming at keeping an excessive population on the land. She called for a reconstruction programme based on high nutritional standards, more efficient farming, freer trade within a planned international economy, freer movement of populations and a wide development of rural industry.

Dr. L. Feierabend believes that agricultural evolution in Europe must be in the direction of small, individually owned farms working co-operatively. He distinguished clearly between co-operative and capitalistic farming. The primary aim of a co-operative society should be not the making of profits, but "the support of the business of its members", that is, the improvement of the land. He agreed with other speakers that a high standard of education is a necessary element in the success of any co-operative scheme. Mr. S. Malessa stressed the inter-dependence of agricultural and industrial planning. The problem of rural overpopulation can only be solved by industrial planning to absorb the surplus.

Dr. L. Dudley Stamp outlined the geographical factors determining and limiting the types of crop production feasible in Europe, and advocated planning on a regional rather than on a political basis. Dr. J. Krnjević described the political emergence of the Croatian peasantry, comprising 90 per cent of the population, through the cultural activities of the Croat Peasant Movement.

Dr. J. Hammond gave an account of artificial insemination, which several speakers thought could play an invaluable part in restoring the quality and quantity of livestock. Mr. A. Fjelstad dealt with practical problems of the small livestock farmer in Norway, and Mr. P. H. Pedersen with practical aspects of milk production in Denmark. Both the last two speakers stressed the importance of effective co-operation in small-scale, intensive farming.

QUANTUM THEORY AND DIFFUSE X-RAY REFLEXIONS

By G. D. PRESTON

National Physical Laboratory

THE origin of certain anomalous X-ray reflexions, that is to say, intensity maxima the presence of which cannot be explained by the usual diffraction theory, has recently been the subject of investigation in many laboratories. Some account of the work carried out in Great Britain was given at a discussion held in London on February 6, 1941, and a review of this discussion appeared in NATURE of April 19, 1941, p. 467; a fuller account has been published in the *Proceedings of the Royal Society*, A, 179, 1–102, 1941. The progress made in the investigation of this interesting subject in India has recently been reported in the *Proceedings of the Indian Academy of Sciences* of October, 1941, which is wholly devoted, to quote from the cover, to a "Symposium of papers on the Quantum Theory of X-Ray Reflection and the Raman Reflection of X-Rays in Crystals". This description of the subject-matter reflects very clearly the difference in the interpretation of the phenomena which exists between French, American and British physicists on one hand, and the group of Indian physicists at Bangalore working under the leadership of Sir C. V. Raman on the other.

Before considering the nature of this difference of interpretation, it will be convenient here to indicate the scope of the papers presented to the symposium. Sir C. V. Raman contributes two papers on the theoretical aspect of quantum X-ray reflexion, and in collaboration with Dr. P. Nilakantan provides experimental confirmation from a study of diamond, a crystal the reflexion from which is also discussed by P. Rama Pisharoty. Dr. C. S. Ventakateswaran contributes six papers; one illustrates the change of intensity of the anomalous reflexions at low temperatures and the remainder deal with the patterns formed by rock salt, naphthalene, benzophenone and hexamethyl-tetramine. Benzil is investigated by R. V. Subrahmanian, and aluminium and calcite receive attention from Bisheshwar Dayal, P. Nilakantan and P. G. Nayar. This brief outline of the field covered on the experimental side will serve to show that, whatever differences of opinion exist as to the origin of the reflexions, the phenomena investigated are in fact the same as those studied in France by Laval, in the United States by Wadlund, Zachariasen and Siegel, and in Great Britain at the Royal Institution and the National Physical Laboratory.

It is perhaps worth while here recalling the salient features of the effects observed. When a single crystal of, say, aluminium, rock salt or sylvine is mounted in a beam of X-rays which traverse the crystal in a direction parallel to a cubic axis, a Laue photograph is obtained if the beam consists of 'white radiation'. In addition to the Laue spots, there appears on well-exposed plates a number of streaks, running through the Laue spots, which apparently should have no business there. When the composite X-ray beam is replaced by a monochromatic beam, the usual theory of crystal diffraction tells us that no reflexion should be observed unless the crystal is orientated in a particular way. In general, the condition for reflexion will not be satisfied, except by a lucky accident, and a blank photograph should result. However, in fact, reflexions are observed. They are faint, but have the symmetry proper to the crystal axis in which the incident X-ray beam lies. Examples have been published in the pages of NATURE (143, 76 (1939); 147, 467 (1941); 148, 112 (1941)). It is this background of 'non-Laue' diffuse reflexions that is attracting the attention of X-ray crystallographers. To what is it due?

There appear to be several possible answers to this question. The most comprehensive is perhaps to say that the diffuse background arises as a direct result of departures from geometrical perfection in the crystal architecture. A periodic flaw, a regular precipitation of an impurity such as produces a Widmanstätten pattern, and the temperature vibrations of the atoms are all possible and probable causes. It is the task of the experimenter to devise means of identifying the different causes so that use may be made of the machinery provided by the mathematician to enlarge our knowledge of the solid state. Those features of the background reflexions which occur in crystals of pure substances, so that

flaws and chemical segregation are excluded from consideration, are evidently of great importance. There is general agreement on all sides that this background is due to movement of the atoms or molecules of the crystal from their positions of perfect geometrical alinement. The differences of interpretation arise in assigning the cause of the movement and in the mechanism of X-ray scattering. In Great Britain and in the United States, the whole effect is ascribed to the thermal vibrations of the crystal lattice. Just as the Laue and Bragg reflexions are a picture of the static geometry of the crystal, so the diffuse background is a picture of the dynamic vibrations of the crystal. The undisturbed crystal can be regarded as a medium in which the density varies periodically in space, and the effect of the temperature vibrations is to superimpose a spectrum of much longer elastic waves on the natural periodicity of the crystal. The whole crystal then diffracts as a unit and the resulting pattern consists of the usual Laue reflexions plus a background due to the motion of the atoms.

The point of view adopted by the Bangalore group of physicists is rather different. In places I find it obscure and can only hope that the following brief paraphrase of their views does them no injustice. To begin with, the quantum aspect of the interaction of X-rays with the atoms of the crystal is emphasized. The radiation scattered from an oscillating atom is stated to consist of three components, the amplitudes of which depend on the amplitude of oscillation of the atom, and which differ in frequency. The first component, which gives rise to the normal reflexions, has the frequency ν of the primary X-ray beam, while the other two have frequencies $\nu \pm \nu'$, where ν' is the frequency of the atomic oscillation. The frequency change is unfortunately too small to be measured directly.

The atomic oscillations which produce the frequency modulation are supposed, according to Raman, either to arise as a result of direct excitation by the incident beam or to be present as thermal vibrations. The existence of the latter does not seem to be essential; it is sufficient that the atoms are capable of being set in motion by absorbing energy from the X-ray beam—the interaction of the primary X-ray beam with the oscillating atoms then produces the effect. The character of the possible atomic movements is classified into two essentially different parts falling in the infra-red and the elastic ranges of frequency respectively. Raman imagines the elastic low-frequency vibrations of the crystal lattice to arise from the displacement of the lattice cell as a whole from its equilibrium position. Interaction between these vibrations and the X-ray beam gives a background of diffuse scattering of low intensity proportional to the number of lattice cells irradiated. The scattered energy is spread over a wide range of angles so that the elastic waves, it is stated, cannot produce a sharp reflexion.

To the infra-red modes of vibration is ascribed the principal role in producing the observed reflexions, with intensities proportional to the square of the number of lattice cells. These modes of vibration are supposed to arise from the movements of the atoms within the cells of the lattice. There is a difficulty here: the classification of the vibrations will hold for molecular crystals such as benzil, say. In these we might suppose the (infra-red) vibrations of atoms within one molecule to be controlled by forces different from those which control the vibration of the molecules as a whole (elastic waves). But in metal crystals we can choose a cell containing but one atom, and there is no distinction to be drawn between the vibrations of the atoms as a whole and those of the lattice. The metals aluminium, sodium and lead all show, however, pronounced diffuse reflexions, although the elastic waves are not supposed to be capable of producing such an effect. Moreover, Raman explicitly assumes, as a limiting case it is true, that the infra-red vibrations have identically the same frequency, amplitude and phase in all the lattice cells of the crystal: in order that the centre of gravity of the cell may remain fixed, some atoms must move in opposite directions to others, an idea that leads to difficulties as the number of atoms in the cell diminishes.

When the assumption just mentioned as to the identity of phase of the infra-red vibrations in all lattice cells is abandoned, it is assumed that the phase varies slowly from place to place in the crystal. We are then presented with the difficulty that the variation of phase is propagated through the crystal, a process which must involve the elastic properties of the lattice; yet these are supposed to be without effect in producing the most salient features of the X-ray pattern.

It seems unlikely that the quantum hypothesis as set out by Raman can be reconciled with the elastic wave explanation unless one or other hypothesis is radically altered. Although Sir C. V. Raman is confident that his quantum mechanism is essential, it must be admitted that the "thermal-elastic" theory does give a reasonably accurate account of the observed facts.

OBITUARIES

Prof. L. J. Henderson

BY the death of Lawrence Joseph Henderson, the U.S. National Academy has lost its foreign secretary, Harvard University a notable personality, and the United States an outstanding man of science.

Henderson was born in 1878. He graduated at Harvard in arts and medicine. A couple of years were spent in Strassburg, principally in Hoffmeister's laboratory, but he spent some time acquiring technique in organic chemistry in Thiele's institute, and his mind at that time was in close contact with that of Faust and the work of Schmiedeberg's laboratory. On returning to Harvard, Henderson was made lecturer in biological chemistry; in 1910 he became assistant professor, and in 1919 professor.

A remarkable range of knowledge enabled Henderson to contribute in ways not open to those whose intellectual background is more restricted. Versed in the disciplines of mathematics, science, and philosophy, he could place a physiological problem either in a more mathematical or a more philosophical frame than could most of his contemporary biologists. On the other hand, the manipulative aspect of experimental science made little appeal to him, and probably the particular satisfaction of 'bringing off' a difficult experiment was something which he was content to leave to others.

About the time when Henderson graduated, the buffering of fluids was one of the growing points both of physical and biological science, and Henderson's first notable work dealt with that subject (for example,

"Das Gleichgewicht zwischen Basen und Säueren im tierschen Organismus", *Ergeb. der Physiol.*, 8, 254). The milestone which marks that phase is the "Henderson-Hasselbalch equation", stating that the hydrogen ion concentration of a solution containing carbonate, bicarbonate, and carbon dioxide is proportional to the ratio of the free to the combined carbonic acids. Perhaps his greatest contribution was his description of blood as a physico-chemical system. He described the red corpuscles in terms of the concentrations of eight components so connected that the alteration of any one equilibrium invoked a consequential alteration in all the others. This doctrine Henderson elaborated in his classical book "Blood"—the written record of his Silliman Lectures—in which, both for normal blood and that characteristic of certain diseases, the consequential inter-relations of the various factors involved were set forth in more than one hundred nomograms.

To such a mind as Henderson's, it was possible to treat of this great field without acquiring any mastery of the precise experimental techniques by which the data were obtained. It sufficed for him if the data which he plotted were reliable. He therefore, in collaboration with van Slyke, organized a large circle of extremely able experimenters, some in New York, some in Boston, and some farther afield, who undertook the necessary analyses.

It was not possible, however, for Henderson to treat of the physico-chemical blood picture, or rather blood kaleidoscope, without being intensely interested in the philosophical relation of environment to the change which it wrought in the blood of the organism. This interest was responsible for two books, "The Fitness of Environment", and "The Order of Nature". soThe study of environment at once locates Henderson's veneration for Claude Bernard, and the name of Claude Bernard leads to Henderson's love of France. He particularly enjoyed the tenure of exchange professorships at Paris and Grenoble. He held the Legion of Honour, and was a foreign member of the Académie de Médecine (Paris). He travelled on French ships, and enjoyed French wines and French cookery. Henderson was no mean cook himself; indeed, during the war years of 1917–18 he was a constituted American authority on the properties of gluten and the science of baking. Other books were "The Fitness of Environment, and "Pareto's Sociology".

Henderson was a wonderful friend and a wonderful host, particularly perhaps at his summer camp, at Morgan's Center in Vermont. He loved to entertain his friends, and so did his wife. Morgan's Center is in hilly country—country which had once been in cultivation, but now has relapsed to a birch wood. Here on the edge of the lake, the very edge (so that you can dive in from the verandah), was the central cottage where one ate and smoked; the premises expanded on what Henderson called the 'village system', which meant that he bought some window frames from a Chicago stores, and the local carpenter built a hut of perhaps a couple of sleeping rooms around the windows.

The nineteen-twenties were prosperous years in the United States, and the loyalty of her sons saw to it that Harvard participated in full measure. Under the wise guidance of President Lowell it was a time of great expansion on both the scholastic and social sides. In the planning of this expansion Henderson took a very important part—a part for which his wide academic outlook on one hand, and his great social gifts on the other, made him peculiarly valuable. Chairs were created, departments came into being on a basis of wide culture; among these must be mentioned the Fatigue Laboratory of the Harvard School of Business Administration, which dealt largely with muscular fatigue, in its widest sense, and the establishment of a human base-line in such matters; this was Henderson's peculiar *pied-de-terre*. On the social side the expansion took the direction of an endeavour to incorporate into Harvard what was socially desirable in the older English universities while in no wise doing violence to Harvard itself. While, therefore, Harvard still remained Harvard, new houses of residence sprang up, each presided over by a Master, and named after great Harvard men of former times. Thus there was a considerable increase in the number of men—as we would say—'in College'. But among the other new features of the Harvard constitution was one particularly precious to Henderson, one for which he was largely responsible, and one of which he was himself chairman, "The Society of Fellows"*.

This tribute would be incomplete without a reference to Henderson's intense desire to knit more closely British and American science, and probably he did much more than appears in successfully accomplishing this. Yet his work was a broader one; it was to knit British and American culture, indeed to knit Britain and America themselves, not perhaps formally, but none the less really. It is significant that only illness prevented his giving the Pilgrim Lecture in London.

Lawrence Henderson received many foreign recognitions of his work, including an honorary Sc.D. in Cambridge. He married Edith Lawrence Thayer in 1910 and leaves one son.

A few weeks ago Sir Charles Sherrington passed a photograph of Lawrence Henderson hanging in the Laboratory. He glanced at it and said, half to himself, "A great man, that."

J. BARCROFT.

* The term 'fellow' is used in at least three senses at Harvard. (1) The charter of 1650 vested "sundry guiftes legacies landes and Revennewes in the President and Fellows". Now, the Corporation consists of the President, five fellows and a treasurer, who in the last resort act subject to the Board of Overseers elected by the graduates. (2) The Society of Fellows, consisting of nine senior fellows, of whom the President of the University and the Deans of the Faculties of Arts and Sciences are *ex-officio*, while the chairman (lately Lawrence Henderson) and six fellows are elected by the Corporation and confirmed by the Board of Overseers. The senior fellows select junior fellows and recommend them to the Corporation for appointment. "These men are selected for their promise of notable contribution to knowledge and thought. . . ." A junior fellow has free board-residence in a house and an annual emolument of 1,250–1,500 dollars. (3) Numerous fellowships also exist in connexion with the faculties which are of the nature of senior studentships.

Prof. Walter Nernst, For. Mem. R.S.

IN the passing of Walter Nernst, Nobel laureate, physical chemistry has lost a notable leader. From 1894 he was professor at Göttingen, from 1905 in Berlin, afterwards, until 1924, director of the Reichsanstalt, and from 1925 until his retirement director of the Physical Institute in Berlin. After training as a physicist he became assistant in Ostwald's laboratory in Leipzig, where he was additional professor in 1891, and his earlier work was concerned with the broadening and deepening of what was then the 'new' physical chemistry, which centred around the theory of electrolytic dissociation and was so enthusiastically received and developed in the Leipzig school. Ostwald turned more and more from the atomic and molecular conceptions then

ruling in chemistry, and sought to replace them by "Energetics", or non-hypothetical laws based on the transformations of energy. Nernst always insisted, on the contrary, that thermodynamics and molecular theory must hold equal rank in a complete interpretation of physico-chemical phenomena. This is the key to nearly all his work, and is reflected in the title of his text-book: "Theoretical Chemistry from the Standpoint of Avogadro's Rule and Thermodynamics".

Of the large number of subjects which Nernst investigated, it is only possible in a brief notice to mention some in which he appears as a theorist and experimenter of great originality. These include his work on electrochemistry, the heat theorem and the quantum theory of solids.

In the electrochemical researches, three groups are most prominent. The first was the theory of the galvanic cell based on the idea of electrolytic solution pressure—the tendency of an electrode to throw out charged ions to a limit balanced by the osmotic pressure of the solution, and so to develop a potential difference. The formulæ based on this are still the foundation of the theory of electromotive force. Incidentally, his proposal to use the hydrogen electrode as the standard of electrode potential is still in use. Closely related to this work is that on the potential differences set up between solutions of electrolytes in contact. The theory of the effect of an electrolyte on the solubility of another having a common ion ('solubility product') threw light on many branches of chemical work, and the so-called distribution law, giving the way in which a substance distributes itself between two non-miscible solvents, is one of the most important in the study of heterogeneous equilibrium.

In his treatment of thermodynamics, Nernst made use of Helmholtz's equation relating the diminutions of energy (U) and free energy (A) in a process with the temperature coefficient of the free energy (dA/dT), itself equal to minus the entropy increase ($-\Delta S$), namely, $A-U=T.\ dA/dT$. He used this equation with great ingenuity in various fields, and its form lent itself very well to the discovery of the famous Nernst Heat Theorem (sometimes, and by Nernst himself, called the Third Law of Thermodynamics). By an inductive process, based on an extensive knowledge of the experimental results—another characteristic of his procedure—he singled out a field of changes in which the equation $dA/dT=0$ approaches exact validity as the temperature approaches the absolute zero. This implies that $A=U$, and many years previously he had pointed out that this—the so-called Thomsen-Berthelot principle—had a kernel of truth, which could never be disclosed apart from the numerical data. The Nernst Heat Theorem was at first mostly used in the calculation of chemical equilibria from thermal results. In its later developments its intimate relation with the theory of entropy and statistics has been made clear.

It was characteristic of Nernst that he quickly appreciated new discoveries and theories, and that he usually recast the theory into a more intelligible and practical form which appealed directly to chemists. The quantum theory, which was strangely overlooked in England, he recognized as likely to transform many branches of physical chemistry, and in two directions, in photochemistry and the theory of solids, he turned it to most fruitful applications. In the experimental work on the heat capacities of solids at very low temperatures he showed great skill in devising new apparatus—including the use of a metal block as the calorimetric substance—and gave a firm foundation to the quantum theory of specific heats. He invariably strove towards simplification and elimination of redundancy both in theory and in apparatus, and in this work liquid hydrogen was made available in quantity by means of a very simple and effective apparatus at a time when it was regarded as a rarity in most laboratories. He was also interested in the technical applications of physical chemistry, and the Nernst lamp well illustrates his practical ingenuity.

Nernst's work lies at the foundation of many branches of physical chemistry which are most actively studied at the present time, and all physical chemists recognize his outstanding contributions to their science. J. R. P.

Rev. H. J. Riddelsdell

HARRY JOSEPH RIDDELSDELL entered business after school, but studying in his spare time took the B.A. degree of London and gained an exhibition at Jesus College, Oxford, where he graduated in honours and won the Hall-Houghton Prize. He took Holy Orders, and after holding a curacy at Leeds parish church became sub-warden of St. Michael's College, Llandaff, a post he held for seventeen years. In 1914 he was appointed rector of Wigginton and later became vicar of Bloxham. He retired from parish work in 1936 and died on October 17, 1941.

Riddelsdell's long residence in the country gave opportunity of using his quick eye and active mind in observation of Nature, and enabled him to make a thorough study of the flora of the neighbourhood. In 1907 he published "A Flora of Glamorgan", and from 1901 he contributed numerous notes to the *Journal of Botany* and other periodicals. He was a frequent contributor to the Botanical Exchange Club and sent valuable notes for the annual reports. The difficult and critical brambles became a special subject under the guidance of the Rev. W. Moyle Rogers, and after the death of the latter Riddelsdell became the leading authority on the genus in Britain and determined specimens for collectors. He visited many parts of Great Britain for the purpose of this study and a number of new forms were described.

The work to which Riddelsdell gave most of his leisure and ripe knowledge was the flora of Gloucestershire, sponsored by the Cotteswold Naturalists' Field Club. From 1908 as editor he organized and directed the work of Club members and dealt with the large quantity of lists and records already accumulated. A final revision had begun when illness compelled him to leave the task unfinished.

Riddelsdell was first and foremost a faithful and scholarly servant of the Church, devout and unselfish and loved by all around him. In addition, his energy, enthusiasm and quick apprehension enabled him to accomplish much in his leisure and made him a delightful companion in the field. He was elected associate of the Linnean Society in 1925 and his valuable herbarium is preserved in the British Museum (Natural History). W. C. BARTON.

We regret to announce the death of Captain Guy Dollman, assistant keeper of zoology (first class) in the British Museum (Natural History), on March 13, aged sixty-five.

THE INSTITUTE of CHEMISTRY of GT. 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 position, 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. A list of Laboratory Assistants is also available.

Particulars of the Regulations and Examinations of the Institute can be obtained (free), on application to the Registrar.

All communications to be addressed to The Registrar, the Institute of Chemistry, 30 Russell Square, London, W.C.1.

London Laboratory can supply normal young rats from breeding colony. 300 available immediately, then 100—200 per month. Box 3170, Collins Advertising Service, 26 Mortimer Street, W.1.

The fact that goods made of raw materials in short supply owing to war conditions are advertised in this publication should not be taken as an indication that they are necessarily available for export.

HUDDERSFIELD EDUCATION AUTHORITY

HUDDERSFIELD TECHNICAL COLLEGE

Principal: Dr. J. W. Whitaker, F.I.C.

RESEARCH SCHOLARSHIPS

Applications are invited from graduates or candidates with equivalent qualifications for Research Scholarships tenable for two or more years. The scholarships vary in value from £75 to £150 per annum and are tenable in the Department of Coal Tar Colour Chemistry and/or other departments of the College. The scholarships are open to candidates of either sex. Further particulars may be obtained on application to the Principal.

H. KAY,
Director of Education.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY

SOUTH KENSINGTON, LONDON, S.W.7

PHYSICS DEPARTMENT
(Technical Optics Section)

A Course of six Lectures, by Mr. B. K. JOHNSON, D.I.C., on "Microscopy" will be given on Tuesdays and Thursdays at 4 p.m., commencing on Tuesday, April 21, 1942.

An optional course of practical work (consisting of 8 periods of 3 hours each) will also be arranged. These courses will be suitable for those having to use the microscope in technical practice; they will include advanced methods in microscopy, and ultra-violet microscopy.

Application for admission should be made to the Registrar of the Imperial College, Prince Consort Road, S.W.7. The fees are £1 1s. for the lectures and £2 2s. for the laboratory work.

Physicist and/or Electrical Engineer required for Development Laboratory of large electrical manufacturing company, N.W. London district, must be qualified to undertake detailed research and investigations. Reply with full details of academic and other qualifications, experience, and salary required to Box 844, T. G. Scott & Son, Ltd., Three Gables, London Road, Merstham, Surrey.

VACANCIES FOR FEMALE ASSISTANT PHYSICISTS

(LONDON)

Women educated to Inter Science or Higher School Certificate standard, and who have preferably specialised in Physics, required by Government Department for employment as Assistant Physicists. Starting salary is determined by qualifications and experience between the ranges of £130—£240, plus cost of living bonus of 7s. 6d. per week. Annual increments of £10. Candidates should apply in the first instance to Ministry of Labour and National Service, Appointments Department, Section B/E, Sardina Street, W.C.2, giving particulars of age, qualifications and experience, and quoting reference B673E.

VACANCIES FOR FEMALE ASSISTANT CHEMISTS

(LONDON & BIRMINGHAM)

Women educated to Inter Science or Higher School Certificate standard, and who have preferably specialised in Chemistry, required by Government Department for employment as Assistant Chemists. Starting salary is determined by qualifications and experience between the ranges of £130—£240 (London) and £115—£225 (Birmingham) plus cost of living bonus of 7s. 6d. per week. Annual increments of £10. Candidates should apply in the first instance to Ministry of Labour and National Service, Appointments Department, Section B/E, Sardina Street, London, W.C.2, giving particulars of age, qualications and experience, and quoting reference B667E.

Candidates are thanked for their applications and are informed that selected candidates have been interviewed.—Box 882, T. G. Scott & Son, Ltd., Three Gables, London Road, Merstham, Surrey.

Microscopes, second-hand, a large selection of instruments in perfect condition; 3d. stamp for list.—Chards, Specialists (Est. 70 years), Forest Hill, S.E.23.

ASTRONOMICAL TELESCOPES

6-in. Cooke	£135	0	0
4-in. B. C. & Co. Telescope	£50	0	0
3¼-in. Wray Astronomical Telescope	£35	0	0
3¼-in. Lancaster (Wray Object Glass)	£25	0	0
Table Spectroscope by F. E. Becker	£8	8	0
Hilger Prominence Spectroscope	£5	5	0
Browning D.V. Spectroscope	£4	4	0
Swift Student Microscope	£25	0	0

MICROSCOPES WANTED FOR CASH

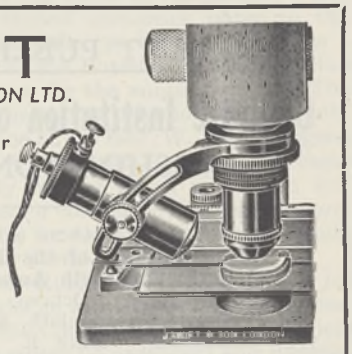
Note name and address:

BROADHURST, CLARKSON & CO. LTD.
63 Farringdon ROAD, London, E.C.1
(3 minutes from Farringdon Street Metro. Station)

JAMES
SWIFT
& SON LTD.

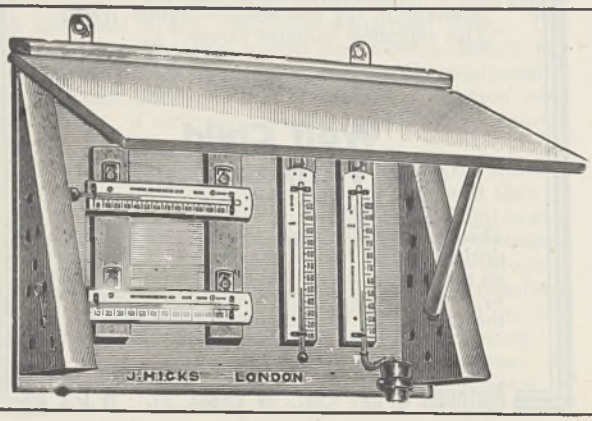
Manufacturers of
MICROSCOPES for
BIOLOGY, MINERALOGY METALLURGY, PHOTO-MICROGRAPHIC & PROJECTION APPARATUS, GONIOMETERS REFRACTOMETERS, SPECTROMETERS, OPTICAL MEASURING & TESTING APPARATUS, POLARISING PRISMS & OPTICAL ELEMENTS

REPAIRS TO ANY MAKE OF ABOVE INSTRUMENTS



Owing to prevailing conditions delivery cannot always be guaranteed.

81 Tottenham Court Road, London, W.1



THE "COLLEGIATE"
METEOROLOGICAL SET

(As illustrated)

Comprising Maximum and Minimum Thermometers and Mason's Hygrometer, all being graduated on the stems and figured on porcelain scales; the whole fitted on a wood screen with an adjustable front, for fixing on wall or post. Also a Snowdon 5-inch Copper Rain Gauge with graduated measure reading to ·01 inch.

JAMES J. HICKS

(Incorporated with W. F. Stanley & Co. Ltd.)

Manufacturer of Meteorological and other Scientific Instruments.

Contractor to H.M. Government.

Catalogue post free.

★ Exceptional Terms to Colleges, Institutions, etc.

8, 9 & 10 HATTON GARDEN, LONDON

The Faraday Society

6 Gray's Inn Square, London, W.C.1.

A GENERAL DISCUSSION on

THE STRUCTURE and REACTIONS OF RUBBER

will be held on FRIDAY, 29th MAY, 1942, from 10 a.m. to 4.30 p.m., at the Hotel Rembrandt, South Kensington, London, S.W.7

The following have promised to send contributions :—

G. S. WHITBY
(*Title not received.*)
W. J. S. NAUNTON
"Rubber Photogels".
E. H. FARMER
"*a*-Methylenic Reactivity in Olefinic and Polyolefinic Systems".
E. H. FARMER, G. F. BLOOMFIELD, D. A. SUTTON and A. SUNDRALINGAM
"The Course and Mechanism of Autoxidation Reactions in Olefinic Substances including Rubber and Drying Oils".
E. H. FARMER
"Ionic and Free Radical Mechanisms in Olefinic Systems, with Special Reference to Processes of Double-bond Displacement, Vulcanisation and Gelling".
J. R. SCOTT
"The Plastic-elastic Behaviour of Ebonite".
R. M. BARRER
"Permeability in Relation to Viscosity and Structure in Rubber".
G. GEE
"The Thermodynamic Basis of the Swelling and Solution of Rubber".
D. D. ELEY
"The Kinetics of Rubber-like Elasticity".
R. F. TUCKETT
"The Kinetics of High Elasticity in Synthetic Polymers".
L. R. G. TRELOAR
"Thermodynamic Study of the Elastic Extension of Rubber".
C. W. BUNN
"The Crystal Structure of Rubber".

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

NEWS and VIEWS

New President of the American Association

PROF. ARTHUR H. COMPTON, Charles H. Swift Distinguished Service professor of physics in the University of Chicago, was elected president of the American Association for the Advancement of Science by the council at its meeting held on December 31. Prof. Compton is well-known for organizing and carrying out world-wide investigations of the reception and properties of cosmic rays, and for the influence he has had on education. He is a member of a family that has become famous in one generation, his brother, Dr. Karl T. Compton, president of the Massachusetts Institute of Technology, having been president of the Association in 1935, and his brother, Dr. Wilson Compton, having been a member of the Finance Committee of the Association during 1933–41. Dr. Arthur Compton was born in Wooster, Ohio, forty-nine years ago. He graduated from Wooster College in 1913, took his Ph.D. degree at Princeton University in 1916, and he has received honorary degrees from several universities. He has been on the faculty of Wooster College, Princeton University, the University of Minnesota, Washington University, and finally in the department of physics of the University of Chicago since 1923. Dr. Compton was a research physicist of the Westinghouse Lamp Company during 1917–19, a national research fellow at the University of Cambridge during 1919–20 and has been special lecturer at several foreign universities.

Thousand Dollar Prize of the American Association

THE nineteenth Thousand Dollar Prize of the American Association for the Advancement of Science was awarded at the recent meeting in Dallas to Drs. Dugald E. S. Brown and Douglas A. Marsland, of New York University, and Dr. Frank H. Johnson, of Princeton University, for two joint papers: (1) "The Reversible Denaturation of Enzymes as a Determining Factor in the Reaction of Biological Systems to Temperature and Pressure" and (2) "The Mechanism of Temperature and Hydrostatic Pressure Reversal of Narcosis in Luminous Bacteria". In these papers an interpretation for the reversible biological effects of pressure is presented, and the quantitative evidence seems to be fully conclusive and is directly referable to basic principles of thermodynamics. In solving the problem of pressure, evidence has been found for a new general understanding of temperature relations in biological processes. A new concept, also supported by clear-cut evidence, is introduced with regard to the mechanism of narcosis. Thus a common denominator appears to have been found for three fundamental factors in biological processes—pressure, temperature and narcosis—wherein diverse effects can now be related to the same fundamental mechanism, itself in accord with familiar laws of physical chemistry.

Dr. Brown was born in St. Thomas, Ontario, in 1901, and studied at the University of Michigan and received the Ph.D. degree from Cornell University. Dr. Marsland was born in Brooklyn in 1899 and received the B.S. and Ph.D. degrees from New York University and the M.S. degree from Columbia University. Dr. Johnson was born in Raleigh, N.C., in 1908 and received the A.B. and Ph.D. degrees from Princeton University and the A.M. degree from Duke University.

First Publication of the Geological Society

AT the meeting of the Geological Society on February 25, Dr. Leonard Hawkes reported the discovery in the Library of the Sedgwick Museum, Cambridge, of the first publication issued by the Society, a pamphlet of 20 pages, entitled "Geological Inquiries". The "Inquiries" were drawn up by a Committee in February 1808, three months after the foundation of the Society, and circulated among the members. At the time when Woodward's "History of the Geological Society of London" was published (1907), it was thought that no copies had been preserved. The pamphlet opens with an "Introduction" dealing with the scope and purpose of geology and with plans for the development of the science. In this we read that "Geology relates to the knowledge of the system of our earth, of the arrangements of its solid, fluid, and aeriform parts, their mutual agencies, and the laws of their changes".

The inquiries, of which there are 130, were collected from various sources "with a view to facilitate and in some measure to direct general research" in the hope "that by the labours and talents of many individuals thus united and assisted, several important objects may easily be attained"; and "above all, a fund of practical information obtained applicable to purposes of public improvement and utility". The following are examples of the inquiries: "Concerning Vallies [*sic*]. Do the opposite sides consist of the same kind of rock, and do they correspond in the inclination of their beds or strata?" "Concerning Organic Remains. Do particular shells, etc., affect particular strata? Are the shells worn, broken, crushed, or thrown out of their natural position? Are the different species confusedly intermixed? Among the various organic remains, can any traces be observed of the existence of man?"

Raw Materials in the New World Community

THE collective organization of all human beings into some form of world community, with a planned co-ordination of human activities of all sorts, was predicted as a result of the War by Prof. Kirtley F. Mather, professor of geology in Harvard University, at the Cranbrook Institute of Science on January 30. He considers that, regardless of the outcome of the War, the old order will inevitably be replaced by a new order that is even now being formed. This organization of individuals into a world society is the inevitable consequence of the extensive use of natural resources that are unevenly distributed over the face of the earth. The ceaseless flow of things from mine and quarry, field and forest, to processing plants, mills and refineries and thence to consumers is a fundamental necessity in an age of science and technology. It is quite likely that the historian of the future will rate this middle third of the twentieth century as equal in significance to the closing third of the fifteenth century. To-day, just as in that ancient time, human civilization is moving from an era that is closing into a new era that is opening.

There is actually an abundance of the needed raw materials, Dr. Mather said. A careful appraisal of the world stores of non-renewable resources, including known substitutes for such resources as petroleum that are known to be present in insufficient amounts, reveals the fact that there is enough and to spare of all the necessary raw materials to provide the physical basis for the efficient, comfortable existence

of every human being who is likely to be born anywhere on the earth during the next two thousand years at least. Science and technology are even now inaugurating a new relationship between man and the things he needs or thinks he needs. For a century or more the tendency has been to use more and more of the non-renewable resources, Nature's stored capital, and relatively less of the renewable resources, man's annual income. For example, between 1900 and 1925 we used up more of the world's resources of the various metals and mineral fuels than had been used by man throughout his entire history prior to the year 1900. But within the last decade, scientific research has reversed the trend. The expanding chemical industries with their plastics and synthetic resins depend largely upon living things, and these are a product of the potentially inexhaustible resources of the soil. Long before the capital stored by Nature throughout geological time has been exhausted, man may well have learned how to live within his annual income.

History of Anglo-Czechoslovak Relations

UNDER the Czech title, "Sedm Set Let angločeských Vztahů", Dr. Kamil Kleiner has written for the benefit of Czechoslovak readers outside Nazi domination an account of the links between his nation and Britain. The earliest connexions were mainly exchanges between the theologians and educationists of the Universities of Oxford and Prague. With the development of the Bohemian University, founded by Charles IV in 1348, other learned men were attracted to Prague. Among them were Dr. John Dee, mathematician to Queen Elizabeth, and Edward Kelley, who visited Rudolf II in 1584 and stayed some years in Bohemia, which was then an important centre for alchemy and astrology. Dee eventually returned to England, but Kelley remained and after a chequered career died, according to Dr. Kleiner, in prison at Most in 1591.

After the time of Comenius's visit to England, 1641–42, there were few non-political contacts between Czechoslovakia and Britain until the nineteenth century, when English works were widely translated into Czech as a consequence of the national movement which began about 1790 with a revival of interest in the natural sciences and gained momentum in the early part of last century. The restoration of the Czech University in 1882 (it had been Germanized after 1620 when the Czechs lost their independence at the beginning of the Thirty Years' War) gave a further impetus to cultural relations with men of science and learning outside Bohemia. Czech students came to England, and British students and others, men of science among them, studied in Czechoslovakia, especially during the twenty years of independence. The disastrous developments of the last few years may still serve to strengthen the ties between Britain and Czechoslovakia.

Future of the Railway Oil Engine

ACCORDING to B. Reed, in a paper read before the North-East Coast Institution of Engineers and Shipbuilders, the most important factor influencing the whole future of any transport engine will be the fuel available. It will be absolutely necessary that the type of oil engine now used in road and rail transport shall be able to burn successfully fuels inferior to the present light Diesel oils. All development and applications will be governed very largely by this one factor, and the solution of the problem cannot be tackled too early. The spread of the War is increasing the difficulty of access to crude oil producing areas, and there is a question of whether the supply of fuels with a high cetane number will give out before the majority of high-speed engines have been adapted to burn successfully the lower grades of oil. Considerable technical progress has been made already in the burning of tar oils and vegetable oils, but the majority of engines are suitable only for the light Diesel fuels. The large slow-running locomotive type of engine certainly can burn heavy crude fuels without a great amount of trouble, but the far more numerous smaller high-speed engines for rail-cars and train sets need concentrated study, because it is essential they should be able to burn the poorer and heavier fuels without diminution in top rotational speed. The time available for ignition and combustion is one of the factors deciding the suitability or practicability of a fuel. Any standard engine of the future ought to be suitable for burning two or three different kinds of fuel, say, two heavy minerals and a vegetable oil, with the least possible modification.

Influx of Rare Winter Birds into Britain

THE recent severe winter, like that of 1939–40, has brought a considerable number of uncommon winter birds to various parts of the British Isles. In *The Times* of February 10, *et seq.*, Dr. D. A. Bannerman and others have reported most unusual numbers of rare waterfowl on the Thames at London, including pintail, gadwall, goosanders and hundreds of tufted duck, pochard, mallard and several shoveler, teal, shelduck, cormorants, coot, glaucous gull, great crested grebes, etc. The No. 2 (March) war-time number of *Country-Side* records the Iceland gull at Hammersmith; firecrests in Middlesex; eider and brent goose in Cheshire; barnacle geese, Bewick's swans, hen-harrier and hooded crows in Lancashire; siskins in Cumberland; smew, golden-eye and black-necked grebe at Tring (Herts); a flock of nineteen waxwings in Norfolk feeding on privet; great grey shrike and goosander in Surrey.

Later this winter the Merseyside Naturalists' Association has reported in Cheshire smews, goosanders and the red-necked grebe; smews, bittern, golden-eye and velvet scoter have been at the Ellesmere lakes, Shropshire, while an invasion of waxwings has included many flocks in the eastern half of the country, especially in Yorkshire (*Naturalist*, February), but they have extended their invasion to Dorset (*Country-Side*, March). In Wales there have been black redstarts on the Orme's Head and a flock of fifty siskins in alders in Glamorganshire. Earlier in the winter a flock of 5,000 widgeon was counted in the Ribble Estuary (Hardy, "Birds of the Liverpool Area", p. 167), but a grey lag goose that appeared at Regent's Park was believed to be a tame visitor from Kensington Gardens. Immense flights of knots have been off many river estuaries; flights of grey geese have been unusually numerous over many inland towns. The bulk of the winter visitors, especially the duck, came from Christmas onwards.

Birds of the Midlands

THE Ornithological Section of the Leicester Literary and Philosophical Society has issued a twelve-page county report and status of birds for

1941, as indicated when it was founded last summer, and as well as Leicestershire and Rutland, the report covers Nottinghamshire and Northamptonshire records of importance; 129 species are mentioned in the list, and some interesting visitors were recorded. The unusual influx of uncommon birds during the hard winter, noted from other parts of the country, is also borne out by the January and February 1942 bulletins, which report considerable numbers of gulls and sewage farm visitors. Altogether, the Society's record book has evidence of some two hundred species noted this century.

Principal Timbers of Jamaica

IT is known that until within the last few years there was no forestry department in Jamaica and little information was available on the subject of the remaining forests. Some data have been collected on the chief native timbers and these are published by the Department of Science and Agriculture, Jamaica, in Bulletin No. 29 (New Series), "The Principle Timbers of Jamaica", by Mr. C. Swabey, conservator of forests (Kingston: Government Printers, 1941). Jamaica has a forest history common to many other Colonies of the British Empire. When Columbus first sighted the island it was covered in dense forests. Of these but little remains to-day; the fine mahogany, satin wood, sandal wood, lignum vitæ and other cabinet and dye woods which found their way to the markets of Europe are things of the past, the exports to-day being negligible. The chief reasons are shifting cultivation, failure to replant, felling of young and immature timber, barking of economically valuable trees and wasteful conversion.

The Forestry Department of Jamaica will have a heavy uphill task to face. Meanwhile a wise step has been taken in the issue of this small pamphlet. As the author remarks, it is unavoidably incomplete, but with the collection of further data a re-issue will become possible. In any event some of the chief forest types are here enumerated. A great obstacle to identification, met by no means for the first time in the British Empire, is the correlation of native names. "Not only are different names applied to the same tree in different districts, but the same name is applied to whole groups of trees and to entirely different trees in different districts." This is apparently particularly evident in the sweetwoods (Lauraceæ), the bulletwoods (Sapotaceæ) and the redwoods (Myrtaceæ). A considerable amount of botanical research will be necessary in some cases even to confirm some of the scientific names of certain trees.

Leaf-beetles Collected by Darwin

IN the issue of the *Annals and Magazine of Natural History* of February, Mr. G. E. Bryant of the Imperial Institute of Entomology describes some Chrysomelidæ, or leaf-beetles, collected more than one hundred years ago by Charles Darwin. It appears that the specimens were found while rearranging and incorporating accessions to the collections of the family just named in the British Museum. Those obtained by Darwin were collected by him on the voyage of the *Beagle* during 1832–1836. They are very small, obscure insects belonging to the Halticinæ, or flea-beetle group, and were from South America and the Cape of Good Hope. They came to the British Museum through G. R. Waterhouse and by purchase at the sale of the collection of the Entomological Society of London in 1850. It may be mentioned that the British Museum received some 2,500 specimens from G. R. Waterhouse.

Vaccination in Napoleonic France

IN a recent paper (*Bull. Hist. Med.*, 10, 635; 1941) Dr. Robert C. Dunbar remarks that the introduction into France of one of the most important scientific discoveries of modern times was delayed by war between France and Great Britain, and by the difficulties of preserving cow-pox virus. War, however, was much less totalitarian at the beginning of the nineteenth century than it is to-day, as is shown by the fact that Jenner, with the consent of an enemy Government, could enter enemy territory to introduce a new medical practice. The medical men of Geneva, especially Prof. Marie Auguste Pictet and Dr. Louis Odier, played a prominent part in the introduction of vaccination into France. The French medical profession in the Napoleonic era, though ready to receive new ideas, was at the same time very cautious, and refused to accept Jenner's discovery until its value had been confirmed by numerous tests in various parts of France, particularly Paris, Lyons, Rheims, Bordeaux and Metz. The new discovery was favourably regarded by the personnel of the Consulate and most of all by Talleyrand, while Napoleon himself had a high esteem for Jenner.

Epidemics in Haiti

ACCORDING to Dr. Rulx Léon (*Bol. Of. San. Panamericana*, 21, 31; 1942), ex-Secretary of State in charge of the Public Health and Social Assistance Service, several severe epidemics of smallpox occurred in Haiti in early times, including those in 1518, 1738, 1740 and 1741. In 1518 treatment chiefly consisted in the patients bathing in a river. In 1825 when another outbreak occurred, the soldiers were vaccinated. It was not until 1920 that the people began to take vaccination and isolation seriously as means of controlling the disease. The first case of yellow fever, imported from Martinique, was reported in Haiti in 1691. Epidemics occurred afterwards in 1733, 1735, 1739, 1743, 1745 and 1746, and were followed by very severe outbreaks in 1798, 1802, 1803 and 1804. No further epidemics of yellow fever occurred in Haiti, but a few sporadic cases were reported from time to time, confined to the white colony. Epidemics of malaria and typhoid were also reported in Haiti in 1739, 1742, 1744 and 1766. The endemic diseases which often proved fatal in Haiti were mumps in 1740, measles in 1741 and 1889, rabies in dogs and humans in 1762, 1768 and 1782. An epidemic of influenza with pulmonary complications also occurred in 1852. Three years ago, Port-au-Prince had its second epidemic of diphtheria since 1892, and in 1935 anthrax made its first serious appearance since 1775.

Meteorology in Burma

THE Government of Burma's official "Report on the Administration of the Meteorological Department, Burma, 1937–41" is the first—and until the situation in the Far East becomes very different will also be the last—report of a meteorological service that was formed as a consequence of the separation of Burma from India. In November 1936 the Government of Burma decided to set up this Service

with the aid of Dr. C. W. B. Normand, director-general of observatories, India. Burma was already in possession of some observatories that had formed part of the India Meteorological Service, and according to the scheme worked out by Dr. Normand, these were to be maintained to form the backbone of the new service, while the former forecasting office at Rangoon, which was closed down as a measure of economy in 1932, would be reopened to form its headquarters. It was also arranged that at first the Meteorological Office at Calcutta would retain responsibility for the issue of storm warnings to ports on the coast of Burma. The Government of India gave further important help for the scheme by agreeing to the appointment for five years of Dr. S. C. Roy, one of the senior meteorologists of the India Meteorological Department, as the first director of the Burma service, and of Mr. S. S. Lal and Mr. S. K. Das as assistant directors for the same period.

Administrative control of the observatories of Burma began on April 1, 1937, and by July 1, 1937, all meteorological work in Burma, except gale warnings for shipping and the supply of hydrogen to pilot-balloon stations, was in the hands of the new service, which in the short period of its existence made good progress in developing its organization. Arrangements were made for daily pilot balloon ascents at the two airports, at Akyab and Mingaladon, from the beginning of 1939, and during the four years under review six new second-class observatories were begun. A workshop and laboratory for the repair of instruments were set up. The Government of Burma agreed to the acceptance by the director of membership of the International Meteorological Organization. Of all this activity there is probably no trace left; if the service is revived after the War it will presumably have to begin again at the very beginning.

Earthquakes registered in New South Wales

ACCORDING to the seismological bulletin of the Riverview College Observatory, recently received, sixty-four earthquakes were registered at the Observatory during July–September, 1941. These were divided as follows: eighteen in July, twenty-one in August and twenty-five in September. On August 2 a strong earthquake commenced recording with iP_{EZ} at 11h. 47m. 09s. U.T. from an estimated epicentral distance of 28·9°. The first pulse was condensational, and the maximum amplitude attained on the Galitzin seismometer was 67·5 mm. (magnification 311), at 57m. 18s. U.T. The shock finished recording at 15h. 30m. U.T., having lasted nearly 3h. 43m. Some of this spread would be caused by the difference in speeds of the various types of waves from the focus. On September 4 a strong earthquake commenced recording impulsively on all three components at 10h. 27m. 38s. U.T. from a probable epicentral distance of 3,100 km. (= 27·9°). The epicentre of the earthquake was estimated provisionally to be at lat. 7° S., long. 155·5° E. which is near Bougainville in the Solomon Islands. It attained a maximum absolute ground amplitude at Riverview of nearly 0·09 mm. at 10h. 36m. 27s. U.T. and finished recording at 14h. 20m. U.T., having lasted approximately 3h. 52·5m. On September 12, 1941, an earthquake of considerable severity commenced recording impulsively on all three components (NS, EW and vertical) at 07h. 09m. 15s. U.T. from a rather doubtful epicentral distance of 37°. Maximum amplitudes of 56·1 mm. (E with $V = 305$) were attained on the Galitzin records at 07h. 26m. 32s. U.T. and the earthquake finished recording at 09h. 25m. U.T., having lasted some 2h. 15·75m. The recording is strongly suspected of having come from a multiple shock. These three recordings appear to have been the greatest during the three months. Some of the lesser recordings have been somewhat interrupted by microseisms, which makes their interpretation difficult.

International Seismological Summary

THE International Seismological Summary, for July–September, 1934 has just been received. It was prepared at Oxford by, and under the supervision of, Miss E. F. Bellamy and sent to the press on September 17, 1941. In all, 183 epicentres and initial times of earthquakes were calculated from data supplied by observatories throughout the world. Of these epicentres 127 were repetitions from old epicentres and 56 were new. It is well known that lines of weakness in the earth tend to persist so that repetitions of earthquakes are relatively common. Eight of the earthquakes listed (with most of the instrumental data concerning them) were exceptionally well recorded while 83 were poorly recorded, probably because they were weak shocks. Only two of the shocks are suspected of having a depth of focus other than normal (presumably about 15 km. deep). The small number of abnormal shocks is thus outstanding. Of the two shocks concerned, one was on July 22 at 19h. 57m. 0s. U.T. with a depth of focus 0·025 of the earth's radius below normal and an epicentre at lat. 36·5° N., long. 70·5° E. which is in the Hindu Kush mountains to the north-east of Kabul; the other occurred on August 30 at 16h. 25m. 57s. U.T., had the same depth of focus, and an epicentre at lat. 19·3° N., long. 145·7° E., which is to the north end of the Challenger Deep in the Pacific Ocean. Both these areas have been the scene of moderately deep focus earthquakes in the past so that the occurrence is not surprising.

Seismic Surveying in New England

FROM *Earthquake Notes* of December, 1941, the new editor of which is Mr. A. K. Ludy, we learn that at least two groups have been conducting seismic surveys in New England during the past few years. The majority of studies have been concerned with the depth of glacial deposits over the underlying bedrock in an attempt to discover something more of the preglacial history of the area in question. The Lowell, Mass., quadrangle was thus studied by Dr. F. W. Lee and others. The Weston Seismic Unit has made similar studies about the area of Boston in studying the bed of the preglacial Charles and Mystic Rivers. The most recent survey by this unit was an underwater survey in the bed of the present Mystic River near Everett, Mass. Under-water equipment was loaned to Weston College by the Humble Oil and Refining Co., of Houston, Texas. Seismic surveys of the Triassic rocks of the Connecticut River Valley were made during the summer of 1941 by the Weston College Unit near Springfield, Mass. The depth to the base of the Triassic formations as well as preglacial topography were measured in several places near the Massachusetts - Connecticut State line. This study was made in co-operation with the Geological Society of America.

Public Address Systems

IN a paper with this title, read recently before the Institution of Electrical Engineers, Mr. S. Hill, of Standard Telephones and Cables, Ltd., first outlines the classification of public address systems and then proceeds to a brief mention of the early history of the art. The basic elements, that is, the microphone, amplifier and loud speaker are next reviewed, an illustrated description being given of the double-button, moving-coil and cardioid types of microphone; typical polar characteristics are shown in the case of the latter type of instrument. Mention is made of the interrelation between public address technique and the art of architectural acoustics, and it is suggested that the architect should have some basic knowledge of acoustics and the advantages and assistance given by a public address system, or that he should co-operate with acoustic experts. It is, for example, extremely difficult for the public address engineer to install a system in a completed building when he is confronted with artistic as well as technical problems, loud speakers with large exponential horns being very difficult to reconcile with a decorative scheme.

The paper then deals with the general aspects of the planning and installation of sound systems, paying special attention to the problems associated with time interval and reverberation in auditoriums. Reference is made to the disturbing effect of noise, its cause and mitigation. Auditory perspective is discussed and compared with controlled reverberation, mention being made of the remarkable effects which can be achieved by either of these means. A description follows of some typical public address installations, special reference being made to those used for the religious pageant, "Le Vray Mistère de la Passion", performed in Paris in 1936 and 1937 and for the coronation of King George VI and Queen Elizabeth in Westminster Abbey in 1937, and to the system installed in the Argentine Chamber of Deputies in 1939–1940. The paper concludes with a cursory review of present-day trends, and the author remarks that in the present state of the art it is not possible, except in a few simple cases, to determine a unique solution of each problem.

Electrical Space-heating Methods

MR. R. GRIERSON, in a noteworthy paper recently published (*J. Inst. Elec. Eng.*, 89, Pt. 2, No. 7; 1942), dealt with space-heating by means of electrically warmed floors, as applied to surface-type air-raid shelters, from the points of view of the thermal electricity supply and economic problems associated with the subject. The heat storage method advocated employs 'soil heating' cable suitably buried or placed in ducts below the floor surface. The investigation is described in considerable detail, and it has led the author to the following conclusions. No other form of space-heating provides an even approachable standard of thermal comfort for all the shelter occupants in return for the cost of energy used and space occupied. The method provides thermal storage sufficient to maintain the warmth-comfort standard when the electricity supply is interrupted during peak periods or by bomb damage to cables, sub-stations, etc. It provides maximum safety against burns and shock due to inadvertent contact with the source of heat energy.

The space occupied by the installation is very small, as is also the risk of wilful damage. Maintenance, apart from cable failure, is nil. The initial cost of the installation is reasonable, and the total cost of operation compares most favourably with that of other forms of space-heating installations. The thermal capacity of buildings having 14-in. brick walls and 6-in. concrete floor and roof is such that it is technically impossible to provide any acceptable standard of thermal comfort for all the occupants, in response to the turn of a switch. The space-heater described requires no iron or steel, and the total labour per kw. capacity installed is probably the lowest for any form of heater. In view of its inherent characteristic of thermal storage at or about room temperature, it would appear that there is considerable scope for post-war development for certain classes of building.

Electrical Equipment for Farms

THE Federal Security Agency and the U.S. Office of Education have recently issued a useful booklet (Vocational Division Bulletin No. 209) entitled "Building Electrical Equipment for the Farm", which is well worth study by farmers in Great Britain. The numerous uses for electricity on the farm and the widespread increase in rural electrification in the United States during recent years have turned the attention of farmers there to the building of electrical equipment. This publication is accordingly designed to provide teachers of vocational agriculture with reliable subject-matter organized in usable teaching form in order that they may be in a position to offer systematic instruction on building safe and simple electrical equipment for the farm. Its subject-matter has been supplied by the Rural Electrification Administration and other reliable sources, and it includes hints on farm wiring, maintenance and repair; analysis of operative training for the construction of special electrical devices or appliances peculiar to the farm; statements of certain interpretive science and related information in connexion with the various electrical applications; numerous line and half-tone illustrations; a list of the farm uses of electricity; a glossary of electrical terms; and finally, a list of references on electricity and the farm. Details are given for the construction of a poultry water heater, ultra-violet reflector for poultry, electric pig brooder, electric hotbed, electric stock-tank water heater, electric chick brooder and pen, exhaust fan room-cooling unit, and a combination electric room-cooling and garden-irrigating device. Advice is also given on the installation of a portable electric motor. Twelve important rules are given for the safe handling of electricity, and stress is placed on the inadvisability of amateur wiring, it being emphasized that this should be done by a competent wiring authority or electricity undertaking. This booklet should prove invaluable to progressive farmers working large tracts of land, where, because of the distances involved, contacts with skilled engineering labour are few.

Dry Cell Manufacture

IN order to assist Indian manufacturers who have experienced difficulty in producing dry cells comparing favourably with those available in the Indian market, a systematic study of cell manufacture was undertaken in the laboratories of the Government Test House and the results are presented in Bulletin

No. 23 issued from the Office of the Director of Scientific and Industrial Research (Department of Commerce, Govt. of India). The report avoids highly academic discussions of the problems involved and concentrates chiefly on matters immediately concerned with the industrial aspects. Indian firms which had been importing most of the raw materials from Germany before the War (to the value of not less than ten lakhs of rupees a year) have now perforce to seek other foreign sources, and a survey of the indigenous materials was carried out with the view of replacing the foreign products used in cell manufacture. As a result of this, certain Indian manganese ores have been found capable of giving output results comparable with foreign ores of good quality.

The electrochemical theory of cells is briefly treated at the commencement of the Bulletin, which then proceeds to give an outline of cell manufacture. The materials and machines used receive a very comprehensive survey, as also do production methods and testing. The influence of various defects are examined in some detail, and a section is devoted to a consideration of the economic aspects of production. The Bulletin is mainly concerned with the bag type of cell, such of the packed type as are on the Indian market being of foreign origin.

Young Farmers' Club Booklets

THE latest addition to the excellent series of Young Farmers' Club Booklets is No. 9, "Garden and Farm Insects", by A. J. A. Woodcock. Others recently published are No. 2, "Bee Keeping", by R. Gamble, No. 6, "Grassland", by J. O. Thomas, and No. 8, "Goat Keeping". The price of each booklet is 6*d*. or they can be obtained from the National Federation of Young Farmers' Clubs, Oaklings, Canons Close, Radlett, Herts., post paid 9*d*. The booklets are most attractively set out, with first-class illustrations, and the subject-matter is presented in a form which is certain to stimulate interest. Technical terms are not avoided, but are introduced so naturally that they will be absorbed rather than consciously learnt. As introductions to the various subjects the booklets may be unhesitatingly recommended, and they will provide a sound background of information which will enable better use to be made of the more specialized leaflets issued by the Ministry of Agriculture.

Eugenics in India

THE first *Bulletin of the Indian Eugenics Society* (Calcutta, 1941) is an interesting paper of some twenty-four pages. The foreword describes the origin of the Indian Eugenics Society, the headquarters of which at present are in the Bose Research Institute. The aims and objects of eugenic researches in Bengal are described by Mr. S. S. Sarkar, the general secretary of the Society. A general introduction describing the hereditary disabilities occurring in Bengal, and including figures from various sources, is followed by a discussion of the possible methods of eugenic research. One fairly full pedigree from South Bengal is given, but a single pedigree of this nature cannot provide any conclusive information. Towards the end of the paper there is a list of hereditary anomalies, with what the author considers to be their modes of inheritance. The rules and regulations of the Indian Eugenics Society are given.

Population of Sweden

ACCORDING to preliminary figures (*Anglo-Swedish Rev.*, February) there was an increase last year in the number of inhabitants of practically all the towns in Sweden. The population of Stockholm increased by 10,462, bringing the total up to 605,575. In 1940 the number of inhabitants in the capital rose by 7,600 and in 1939 by about 13,600. The number of births in Stockholm is still increasing, being 3,061 at the end of 1941—the biggest for many years, as compared with 1,715 at the end of 1940. In 1939 the excess of births was about 1,500, in 1938 about 1,000, and in 1937 and 1936 only 56 and 45 respectively. For the years 1935 and 1934 there was even a deficit of births, namely, 361 and 491 respectively.

Merseyside Naturalists

AT the annual meeting of the Merseyside Naturalists' Association held in the Liverpool Royal Institution on February 8, Dr. J. C. P. Miller, of the University of Liverpool, was elected president; Mr. R. K. Perry, of Liverpool Museums, vice-president; Lieut. J. Bolton, chairman; Mr. Eric Hardy, secretary; and Mr. J. F. Stirling and Mr. G. K. Robinson, assistant secretaries. A new bird-ringing section was formed under the care of Mr. J. F. Stirling to extend migration studies. The Association's recently published "Handbook on the Birds of the Liverpool Area" (Buncle, Ltd., Arbroath), covering west Lancashire, west Cheshire and North Wales, has proved a success, despite the difficult times for scientific publications. Recording will be continued, and a future handbook on the fishes is contemplated.

Committee on Medical Schools

Mr. E. BROWN, Minister of Health, in the House of Commons, on March 26, replying to Mr. Jewson on the question of the Government's post-war hospital policy in relation to teaching hospitals, said: "The Secretary of State for Scotland and I have decided to set up a committee, under the chairmanship of Mr. W. M. Goodenough, with the following terms of reference: 'Having regard to the statement made by the Minister of Health in the House of Commons on October 9, 1941, indicating the Government's post-war hospital policy, to inquire into the organization of Medical Schools, particularly in regard to facilities for clinical teaching and research, and to make recommendations.' The following have accepted invitations to serve on the committee: Prof. T. R. Elliott, Mr. A. M. H. Gray, Prof. J. Hendry, Prof. A. V. Hill, Sir Wilson Jameson, Prof. J. R. Learmonth, Sir Ernest Pooley, Sir John Stopford, and Miss Janet Vaughan."

Literature of Food Investigation

THE Index to the Literature of Food Investigation, issued by the Department of Scientific and Industrial Research, of which No. 2, Vol. 13, September 1941 has now appeared (London: H.M. Stationery Office. 4*s*. 6*d*.) is compiled by Agnes E. Glennie, assisted by Gwen Davies and Catherine Alexander. It is arranged in fifteen sections under such headings as meat, pig-flesh, poultry and game, fish, eggs, dairy produce, fats and oils, fruit and vegetables, grain products, crops and seeds, theory of canning, engineering, etc., each of which includes brief abstracts covering patent literature as well as periodicals. There is an author index, and the publication brings together references otherwise scattered through a wide range of abstract periodicals.

LETTERS TO THE EDITORS

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

Linkage of Physico-Chemical Processes in Biological Systems

In a previous communication[1] Prof. F. G. Donnan —to whose kindness I am much indebted—has developed further an idea arising out of work in this laboratory[2], concerning the cellular accumulation of potassium ions in association with an intracellular chemical reaction. In this process an external diffusible anion, after passing through the membrane into the cell, is converted into an indiffusible anion or anion complex (using the term 'indiffusible' with respect to the membrane). The case chosen by Prof. Donnan was the simplest, in order to illustrate the principles involved. An important biological limitation of this simplest system would be that equilibrium can occur in this case only with a pressure difference if the potassium is accumulated. On discussing this matter with Prof. Donnan, it seemed to us of interest to present the condition when this limitation disappears, and in terms of the symbols of his letter.

We need consider only the final equilibrium state, or :

$$\begin{array}{cccc} & Y^- & \vdots & N^+ \\ (\mathrm{I}) & \Sigma A^- & \vdots & \Sigma A^- \quad (\mathrm{II}) \\ & K^+ & \vdots & K^+ \\ & & M & \end{array}$$

in which (I) represents the interior of the cell, (II) the fluid environment, M the semipermeable membrane, K^+ the potassium ion, N^+ an indiffusible cation (which may be taken as sodium ion) and ΣA^- various diffusible anions, of which one type combines with an indiffusible neutral substance X within the cell to form the indiffusible anion complex Y^-. For simplicity, as before, in order to illustrate the ideas involved, the applicability of the laws of very dilute solution may be assumed, and also that the ions A^- and Y^- are univalent. We have then the following relations (where C denotes molar concentrations, and accented letters refer to II) :

$$C_K = \Sigma C_A + C_Y \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

$$C_K \Sigma C_A = C'_K \Sigma C'_A \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

$$C'_K + C'_N = \Sigma C'_A \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

from which :

$$2C_K = C_Y + \sqrt{C^2_Y + 4\,(C'_K)^2 + (C'_K C'_N)} \quad . \quad (4)$$

and

$$2\,\Sigma C_A = -C_Y + \sqrt{C^2_Y + 4\,\{(\Sigma C'_A)^2 - C'_N \Sigma C'_A\}} \quad (5)$$

whence $C_K > C'_K$ and $\Sigma C_A < \Sigma C'_A$, when C_Y and C'_N have real positive values. Equation (4) gives the quantitative expression for the accumulation of potassium ions in the cell against a gradient. Simple relations can be deduced for the special conditions when the hydrostatic pressures within and without are the same. Thus

$$P_{\mathrm{I}} - P_{\mathrm{II}} = RT\,\{C_K + \Sigma C_A + C_Y - (C'_K + \Sigma C'_A + C'_N)\}$$

$$= 2RT\,\{C_K - (C'_K + C'_N)\} \quad . \quad . \quad . \quad (6)$$

or

$$= 2RT\,(\Sigma C_A + C_Y - \Sigma C'_A) \quad . \quad . \quad . \quad (7)$$

whence, if $P_{\mathrm{I}} = P_{\mathrm{II}}$,

$$C_K = C'_K + C'_N \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

and

$$\Sigma C_A = \Sigma C'_A - C_Y \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (9)$$

These equations show that at equilibrium an *equality* of hydrostatic pressures could occur *together* with potassium 'accumulation' when *both* C'_N and C_Y, that is, the concentrations of the indiffusible cation without and the indiffusible anion within, have positive real values.

The membrane system so described is simpler than that existing between plasma and tissue cells, but indicates certain important relations which have been experimentally verified[2]. For C'_N we may read the sodium concentration of the plasma, and for Y^- a system similar to phosphate esters. The full membrane system for muscle has been treated elsewhere[2], as also the relations controlling the volume changes.

Biochemical Department, Edward J. Conway.
University College,
Dublin.

[1] Donnan, F. G., Nature, **148**, 723 (1941).
[2] Boyle, P. J., and Conway, E. J., *J. Physiol.*, **100**, 1 (1941).

The biological condition, referred to by Prof. Conway, means that he is considering the case of a cell where the semipermeable cell-membrane does not act like an *elastic envelope*, the distension of which, when the cell volume increases, produces an increase of hydrostatic pressure inside the cell, but like an *inelastic surface-layer*, the superficial area of which can vary with variation of the cell volume without affecting the internal hydrostatic pressure, the latter remaining sensibly equal to the hydrostatic pressure in the fluid environment. Prof. Conway has made this point quite clear in the investigation published in the *Journal of Physiology*, to which he refers. In this publication Prof. Conway has deduced a remarkable cell-volume relation, which he has experimentally verified in the much more complicated case of the muscle fibre - plasma equilibrium. I hope Prof. Conway will not consider it an intrusion if I indicate briefly how his reasoning can be easily applied to the simpler case considered in his communication (the symbolism and equations of which I shall use).

From the equations relating to electrical neutrality in (I) and (II), and the equation of membrane equilibrium, we have

$$C_K(C_K - C_Y) = C'_K(C'_K + C'_N).$$

Combining this result with Prof. Conway's equation $C_K = C'_K + C'_N$ (which results from the equality of hydrostatic pressures), we obtain at once

$$C_K = C'_K + C_Y.$$

Hence $C_Y = C'_N$. This means that the condition of equality of pressures *alone* gives the relation $C_K = C'_K + C'_N$, while this condition *plus* the three other conditions (electrical neutrality in both phases and the ionic membrane equilibrium) yields the relation $C_K = C'_K + C_Y$. Thus we cannot have equilibrium with *both* these two relations unless the (internal) C_Y equals the (external) C'_N. Now C_Y may be put equal to $[X]/V$, where V is the cell volume, and $[X]$ is the original mass of X in the cell (X denoting the neutral indiffusible substance inside the cell, from which Y^- is produced). From this it follows that C'_N *determines the cell volume*, when the experimental conditions are such that $[X]$ is sensibly constant.

In conclusion, I am much obliged to Prof. Conway for his elucidation of the biological condition, and wish to thank him for his very courteous reference to my humble effort.

F. G. Donnan.
The Athenæum,
London. March 12.

Dispersion of Cellulose Strands in Cell Walls

In the cell wall of plant fibres the submicroscopic cellulose strands are orientated in parallel. With some bast fibres they are orientated parallel to the cell axis (fibre texture), and with wood fibres or cotton hairs they follow the thread of a screw (spiral texture). In other cell walls the optical anisotropy suggests a dispersion of the cellulose strands as, for example, in sieve tubes and latex vessels (tube texture) or a complete random orientation as in certain parenchyma cells (folium texture)[1]. Such membranes must be built of a submicroscopic 'reticular texture' in opposition to the 'parallel texture' of the first-mentioned type.

From his research on conifer tracheids, the Valonia cell wall and the parenchyma of the Avena coleoptile, Preston[2] concludes that there exists only one type of submicroscopic cell wall texture, namely, the 'spiral texture', from which the fibre texture can be derived by steepening the pitch of the spiral. Therefore he takes only parallel textures into consideration, and the possibility of reticular textures with dispersed and ramified cellulose strands is not discussed: ". . . a change in the *dispersion* of a single direction . . . may only be accepted when other possible causes have been ruled out"[3]. His argument is as follows: The cell walls investigated show oblique extinction under the polarizing microscope. The extinction angle is said to represent the pitch of parallelized cellulose strands forming a spiral texture. This conclusion does not hold good, because the statement of oblique extinction proves only an oblique direction of the anisotropy, but by no means that the cellulose strands are parallelized. They may just as well be dispersed symmetrically to the observed extinction direction, which would be the statistical result of variously inclined cellulose strands.

Whether there is dispersion or not can be determined by the X-ray method or—as the X-ray analysis of single cell walls of isolated cells is impossible at the time being—by the tedious way of measuring the refractive indexes of the cell wall quantitatively. If all wall substances except cellulose are removed, we must expect the indexes of crystallized cellulose parallel and perpendicular to the observed pitch of the spiral[4]. But if there is dispersion those indexes have to be found between the major and the minor index of crystallized cellulose[5].

Fortunately there is a third, much simpler, way to prove the existence of scattered cellulose strands in membranes where dispersion occurs. After staining cell walls with chlorozinc-iodine a remarkable dichroism is observed in the polarizing microscope: in membranes with parallel textures the light is almost completely absorbed if the direction of the submicroscopic cellulose strands is parallel to the vibration plane of the polarizer, whereas no absorption at all is observed if the direction of the strands lies perpendicular to the vibration plane[6]. Therefore, it is only permissible to attribute a submicroscopic parallel structure to a single cell wall, if it gives the iodine dichroism black-colourless when turning the stage of the polarizing microscope. If, however, the membrane examined shows a measurable light absorption in both its extinction positions, the existence of a dispersion of the submicroscopic cellulose strands is established. In this way it can be proved whether there is a reticular texture in the cell wall examined. The angle of dispersion can even be calculated, if the absorption in the two main directions of anisotropy is measured. It is found that

$$\frac{D_{\parallel}}{D_{\perp}} = \frac{1 - \cos \alpha}{\sin \alpha}$$

where $D_{\parallel}$ is the optical density of the stained cell wall parallel and $D_{\perp}$ perpendicular to the cell axis (in case of parallel extinction), and α the angle of dispersion. By this method it is shown that the cellulose strands in the cell wall of latex vessels of *Euphorbia splendens* include angles of inclination from 0° to about 60° with the direction perpendicular to the vessel axis. The conception of a submicroscopic reticular texture is, therefore, valid for the cell wall examined.

A. Frey-Wyssling.

Laboratory of Plant Physiology,
Swiss Federal Institute of Technology,
Zurich. Feb. 24.

[1] Frey-Wyssling, A., *Z. wiss. Mikr.*, **47**, 1 (1930); Proc. 6th Internat. Botan. Cong. Amsterdam, **2**, 294 (1935); *Protoplasma*, **25**, 261 (1936); **35**, 527 (1941); *Kolloid Z.*, **85**, 148 (1938); *Science Progress*, **34**, 249 (1939).

[2] Preston, R. D., *Phil. Trans. Roy. Soc.*, B, **224**, 131 (1934); *Proc. Roy. Soc.*, B, **122**, 76 (1937); **125**, 375 (1938); *Biol. Rev.*, **14**, 281 (1939).

[3] Preston, R. D., *Ann. Bot.*, **3**, 525 (1939).

[4] Frey-Wyssling, A., *Kolloid Beihefte*, **40**, 40 (1926).

[5] Preston, J. M., "Modern Textile Microscopy", p. 260, London (1933).

[6] Frey-Wyssling, A., *Jahrb. wiss. Bot.*, **67**, 597 (1927).

Ground and Polished Prehistoric Artefacts from Ceylon

Until recently it was the accepted view that Ceylon lacked prehistoric artefacts with signs of grinding or polishing. The Island does possess them, and an interesting collection of large specimens so treated was obtained in association with ground bone artefacts and the common pygmy implements. The large artefacts lay at the surface and down to a depth of 30 cm. in the caves 'Udupiyan galge, lat. 6° 45′ N., long. 80° 20′ E., and Batadomba lena, lat. 6° 40′ N., long. 80° 23′ E., the smaller ones persisting to a depth of about six feet. Dealing solely with the larger, thirty-four were celts and hammer stones fashioned from pebbles and bore drill holes, twelve were slabs of untrimmed stone, generally pitted on both surfaces, possibly 'anvils' employed in making burins, some were grindstones, mortars and pestles (Fig. 1). Several were stained with hæmatite. All were made from the less durable rocks such as amphibolite, granulite, gneiss, basic igneous rock and their combinations with biotite and garnet. They displayed heavy patination, while chert pygmies found alongside were only feebly patinated and quartz ones were almost unaffected; this speedier disintegration explains why the larger artefacts of Ceylon remained unknown[1] until 1940.

In many pebble artefacts the stone worker, after drilling a hole on one surface, had attempted to obtain another in the same place on the opposite side. The presence of several pits on this side suggests that he did not always succeed at the first attempt (Fig. 1; 1, 2). As the ends of these artefacts are battered, they are apparently celts with pits drilled for hafting or gripping.

The 34 celts (Fig. 1; 1, 2) ranged in length from 73 mm. to 127 mm., the grindstone (3) was 114 mm. long, the mortar (4) was 155 mm. by 140 mm., the 12 anvils were 230–80 mm. long and 165–200 mm. broad (5).

Fig. 1.
LARGE ARTEFACTS FROM BATADOMBA LENA.

Bone artefacts comprising single points, rhombic forms with the narrower ends ground into conical points, and unmodified natural structures such as the toothed mandibular of the python (Fig. 2, *y*) and the spur-bearing tarso-metatarsal of the jungle fowl *Gallus lafayetti* Less. (Fig. 2, *z*) were apparently employed as piercing inplements.

In association with the artefacts were remains of animals of other existing species, such as swamp snails and bivalves, tree snails, crabs, mahsier, reptiles and mammals, as well as shells of the nut *Canarium zeylanicum* Bl.

The age of these artefacts needs consideration. There are two prehistoric culture phases in Ceylon[1]: (*a*) the *Ratnapura phase*, existing in association with fossils of hippopotamus and other extinct animals, and generally occurring at 12–40 ft. below the surface; (*b*) the *Balangoda phase*, occurring with remains of existing species and extending from the surface to a depth of about 6 ft.

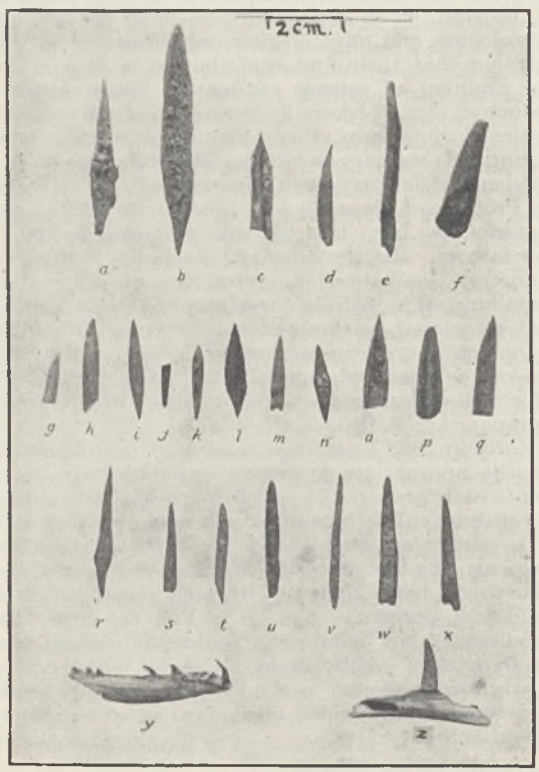


Fig. 2.
BONE ARTEFACTS FROM BATADOMBA LENA.

The position of the larger artefacts here described, and the animal remains, suggest that they belong to the upper level of the Balangoda phase. The conical bottoms of the pits are characteristic of neolithic drilling, while the relatively fresh condition of some of the animal remains, and the survival of the Canarium nut shells, suggest that this culture phase survived until a comparatively recent date. The resemblance of the pitted pebbles to those from British lake deposits[2] and also to others from Bellary near Madras[3], when considered with the abundance of remains of swamp animals, is of interest. The artefacts cannot be ascribed to the so-called Vāddhas, for these possess no tradition of the use of stone weapons, and further, regard the jungle fowl as taboo[4]. There is, however, the Vāddha tradition of an extinct, hirsute, stone-using race of pygmies, the Äyo, who once competed with them[5].

The pygmy artefacts of Ceylon have been regarded by some as the work of a pygmy race, but the large size of the artefacts now discovered in association with such pygmy implements supports the view that their makers were not of abnormal size.

A detailed description will appear in *Spolia Zeylanica*, the journal of the Colombo Museum.

P. DERANIYAGALA.
Colombo Museum. (Director).
Jan. 23.

[1] Deraniyagala, P., "The Stone Age and Cave Men of Ceylon", *J. Roy. Asiatic Soc.* (Ceylon Br.), **34**, 92 (1940): see also NATURE, **147**, 392 (1941).
[2] Evans, J., "The Ancient Stone Implements, Weapons and Ornaments of Great Britain", Figs. 160–165 (1896).
[3] Dalton, O. M., Stone Age Guide, British Museum, 194 (1926).
[4] Seligmann, C. et B., "The Veddhas" (1911).
[5] Lewis, F., *J. Roy. Asiatic Soc.* (Ceylon Br.), **23**, 288 (1914).

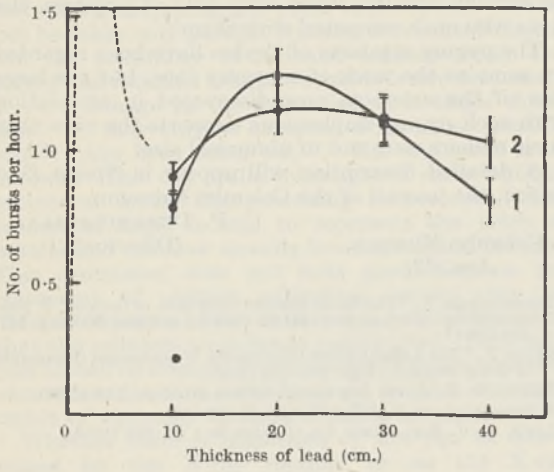
The Second Maximum in the Rossi Curve

IT is well known that the rate of production of cosmic ray showers by layers of any material increases to a maximum as the thickness of the layer increases, and then falls off very slowly for much greater thicknesses, giving the familiar 'Rossi curve'. Certain observers[1] have investigated the rate of production of showers under large thicknesses of iron and lead with coincidence counters, and have claimed the existence of a second maximum in the curve, while more recently Swann and Ramsey[2] have found the effect with tin. Other observers[1], however, have not been able to confirm the presence of a second peak.

Using an ionization chamber to detect and measure cosmic ray bursts produced under large thicknesses of lead, we have obtained evidence for the existence of the second maximum in the Rossi curve, and found a possible explanation of the failure of some observers to find the maximum with coincidence counters.

Our apparatus consisted of a steel-walled ionization chamber of wall thickness 3 mm. enclosing two coaxial cylindrical wire grids of length 58 cm. and radius 11·1 cm. and 2·5 cm. respectively as electrodes, and containing air at a pressure of 8 atmospheres. The collecting electrode was connected to the grid of an electrometer valve set up in a balancing circuit, and changes in the plate current of the valve caused movement of the mirror of a Moll galvanometer of

period 0·3 sec., this deflection being recorded photographically on a rotating drum. Bursts were recorded with thicknesses of 10, 20, 30 and 40 cm. of lead above the chamber, the sides of which were throughout surrounded with 10 cm. of lead to prevent showers from the walls and ceiling of the room from reaching the chamber. The chamber was placed with its axis of symmetry vertical, and calculations showed that the passage of about twelve ionizing rays through the chamber from a point above it would, on the average, produce a sudden displacement of 0·5 mm. in the trace on the film. We have reasons, however, for suspecting that many of the shower particles which originate in the lead above the chamber and strike the lead walls around the chamber—which is long in comparison with its radius—are scattered back into the chamber, possibly accompanied by secondary rays, with the result that a kick of 0·5 mm. may correspond to a burst of a very few rays, possibly as few as three or four. Our results, however, do not rest on this assumption.



The accompanying diagram shows the rate of production of bursts, corresponding to kicks of between 0·4 and 0·6 mm. (Curve 1), and that for kicks greater than 0·6 mm. (Curve 2). The limits of error indicated for each experimental value on the diagram refer to the standard deviation. The general form of the Rossi curve for thicknesses of lead less than 10 cm. is indicated for purposes of comparison (broken curve). It will be seen that the curve for the smallest bursts has a very pronounced maximum at about 20 cm., a value agreeing within the limits of experimental error with those obtained by the observers who have obtained a noticeable maximum with the use of counters. The curve for the larger bursts is, on the other hand, nearly flat.

This suggests that the failure of some observers to obtain the second maximum with counters is due to the fact that the probability of detection of a shower with most counting systems increases with the number of ionizing rays in the shower, so that with some arrangements of counters and for large thicknesses many of the observed coincidences would be due to many-particle showers. This would tend to result in a curve which was fairly flat like Curve 2. The suggestion seems to be supported by the results of Swann and Ramsey[2], who used an elaborate system comprising a large number of counters capable of recording only double coincidences, and who obtained with tin a definite broad maximum as marked as that of Curve 1. Schmeiser and Bothe[3] found that their curves for iron and lead showed a less pronounced second maximum when the lower two counters of their triple-coincidence system were farther apart. They therefore attributed their peak to small-angle 'hard showers', but the assumption of small angles between the shower particles seems unnecessary. We suggest that separating their lower two counters favoured the detection of the larger showers to a greater extent, so that the curve then obtained was more like Curve 2 than Curve 1.

We have obtained preliminary results for iron which already indicate that the same effects occur as with lead, though at greater thicknesses, as would be expected. Full details of this work will be published elsewhere in due course.

C. B. O. MOHR.
G. H. STAFFORD.

Physics Department,
University of Cape Town.
Feb. 2.

[1] *vide* Froman, D. K., and Stearns, J. C., *Rev. Mod. Phys.*, **10**, 133 (1938).
[2] Swann, W. F. G., and Ramsey, W. E., *Phys. Rev.*, **58**, 477 (1940).
[3] Schmeiser, K., and Bothe, W., *Ann. Phys.*, **32**, 161 (1938).

Geologists in War-time

I HAVE read with interest Prof. H. H. Read's account (NATURE, Jan. 10, p. 39) and the leading article in NATURE of March 14 on the lack of use of geologists in the present emergency, and can fully support the criticisms advanced. Included under the general designation 'geologist', however, are a number of other highly trained specialists the neglect of whom is not mentioned in these articles, but who are equally at a loss in their attempts to use their specialized knowledge to increase the war effort.

Every university department of geology includes on its staff, or on that of an associated department, petrologists and mineralogists, who must accept the decision that their first contribution is to continue the training of science students. Even where a reduction of staff leaves little time free from teaching duties during term, this pressure of work relaxes during the necessary vacations. The "fundamental dependence of industry upon mineral products", stressed by Prof. Read, does not end, however, when the raw material has been located, won and transported to the factory. In the chemical (including explosive) industry, the abrasive, refractory, ceramic and metallurgical industries, for example, process control and associated research must continue throughout manufacture and can most easily be achieved by the use of the chemical, optical and X-ray methods in which the petrographer, mineralogist and crystallographer are skilled.

Early in 1939 I played a small part in drawing up for the appropriate authority (on multipage documents each prepared in quadruplicate) a scheme for the utilization of the equipment, resources and staff of a particular laboratory; from that time three years ago the few problems which have reached that laboratory have done so through unofficial and accidental personal contacts. For the rest, the resources of the laboratory remain unutilized, the teaching staff chafe under a sense of complete frustration, while my carefully prepared quadruplicates doubtless languish untouched in some remote pigeon-hole.

F. COLES PHILLIPS.

Corpus Christi College,
Cambridge.

MICROBIOLOGY OF THE ATMOSPHERE

ONE of the symposia held during the fiftieth anniversary celebrations of the University of Chicago last September dealt with the function of air currents, temperature and barometric pressure in disseminating insects, bacteria and such plant diseases as rust. Scientific workers participating in the programme on aerobiology of the American Association for the Advancement of Science, in co-operation with the Committee on Aerobiology of the National Research Council, took part.

According to investigations reported by Claude E. ZoBell, of the Scripps Institution of Oceanography, University of California, bacteria are less abundant in marine air, rain and snow than they are in air masses of continental origin. The ratio of bacteria over oceans as compared to those over land may be approximately 1 to 250. A particle the size of a bacterium would be carried nearly three thousand miles by a steady wind having a velocity of ten miles an hour before it would fall to earth from a height of 100 ft. Though many bacteria in the air are killed almost immediately by sunlight, desiccation and other adverse conditions, marine bacteria are known to survive suspended in the atmosphere for several hours. Terrestrial bacteria found over the ocean hundreds of miles from land necessarily must have been in the air for as long as a few weeks, Dr. ZoBell added.

J. J. Christensen, professor of plant pathology at the University of Minnesota, pointed out that plant spores, such as rust, produced in astronomical numbers, are carried over wide areas by the wind, making control of plant disease difficult. Corn smut, one of the most prolific of plant parasites, can produce a gall twenty to forty cubic inches in size on a corn plant in less than two weeks, and each cubic inch contains about six thousand million spores. A single acre of corn with 10 per cent infection may produce 50 trillion spores. Spores have been found as high as three miles in the air, and high winds, gales, cyclones carry enormous numbers of these pathogens to considerable heights. Because they fall slowly—corn smut spore falls only one hundred feet in four and a half hours—the spores can be carried thousands of miles by air currents to infect crops.

Spores of black stem rust do not survive the hot, dry summers of Tunis, but the crop is infected each year, probably by spores blown across the Mediterranean from Sicily and Sardinia. Australian dust has been deposited in New Zealand. Spores of leaf and stem rust of wheat are regularly introduced into Manitoba by the wind. Excessive rains and such barriers as mountains, large bodies of water and desert constitute real barriers to the passage of the spores and other micro-organisms.

Computations made for all seasons of the year as to the number of insects in a column of air one mile square, starting at 50 ft. above the earth's surface, and extending to 14,000 ft., indicate, according to Perry A. Glick, of the Bureau of Entomology and Plant Quarantine, U.S. Department of Agriculture, an approximate average of 25 million insects. The density of the insects decreases with height. In the day-time, at 200 ft., there are about one half the number found at 20 ft.; at 1,000 ft. there are more than one third the number found at 200 ft.; at 2,000 ft. there are roughly half as many as are collected at 1,000 ft. At times, however, there are wide deviations from the average, as when the mayflies appear or termites are on their dispersal flights. Some species of insects are much more abundant at night than during the day.

Temperature probably has the greatest effect of any meteorological agent on the distribution of insects in the air. The most favourable temperature for insect activity ranges between 75° and 80° F., Dr. Glick said. Dew-point also is an important factor, the most favourable figure for insect activity being a dew-point of about 62°.

At times of approaching storms when the barometer is falling, Dr. Glick said that insects become nervously active. It has been found that the migrations of the sugar beet webworm in Russia is connected with cyclonic depressions. When the air is calm, the insects are not disturbed and relatively few are found in the air. Many insects will cling tenaciously to vegetation when the wind is too great for safe flight. More insects are collected at low altitudes when the surface wind velocity is about five to six miles an hour, but at altitudes from one thousand to two thousand feet a wind velocity of seven to eight miles is more conducive to large numbers.

Although the direction of winds is an important factor in the distribution of insects, such as the migration of the pink bollworm from Mexico to the United States, many insects fly across the wind, or against it. The height to which insects may go is related to their size, weight and buoyancy. Insects with large wing expanse relative to size and weight are found at great heights. Many wingless insects are wind-distributed. Spiders often are numerous in the air, being carried by their silken threads.

Not only the winds but also aeroplanes serve as important distributors for insects, Dr. Glick said. One investigator has found 191 kinds of live insects on aeroplanes arriving in the United States from Mexico and Central and South America.

Insects may be an important factor in allergy, for investigations have shown that insect particles in the air may be greater than all the pollen: butterfly and moth scales in particular may be an important cause of asthma in the United States.

A STUDY IN PLANT ONTOGENY

I. H. BURKILL has recently published (*J. Bot.*; August, 1941) a very stimulating morphological analysis of ontogeny in a pure line of *Ranunculus arvensis*. It is of interest to see the new light thus thrown upon general trends of development, and such studies would form a valuable basis for further developmental studies of an anatomical or physiological nature.

Mr. Burkill notes that the shoot apex, after bearing the two cotyledons, continues to develop primordia according to a regular 2/5 phyllotaxis system which is maintained in the floral axes. The primordia of vegetative and floral parts are initially all alike, distinguishable only during subsequent development, and it is concluded that the nature of their development is determined by the axis. The poorer the nutrition the fewer leaves precede the flower—6, including the cotyledons, in starved plants as against an average of 9 in the spring-sown crop.

The leaves show progressive dissection up the vegetative shoot and the concept is introduced of

"foci of arrest", which make their effect felt progressively earlier, so that, while the first leaves are merely toothed, the later ones are deeply lobed and finally the lamina may be regarded as compound with each main segment carried by a petiolule. This analysis of leaf form succeeds in conveying a vivid and contrasting picture of the progressive complexity of the leaf as compared with the alternative view which stresses the greater laminar growth immediately around each diverging vein.

Leaf asymmetry is very constant in character, the up-spiral (anodic) side of the leaf showing evidence of earlier development of the foci of arrest. Some primordia show signs of transition from foliage leaf to sepal or from petal to stamen and in these two cases respectively the down-spiral (cathodic) side is more vegetative or petaloid.

After its gradual increase in size and complexity, leaf size falls off towards the flower, but size and degree of complexity do not run parallel, so that the first reduced leaves are smaller replicas of the complex vegetative leaves, suggesting that more than one trend is operative in leaf development. Leaf shape also shows a progressive change in general outline from obovate to ovate, this change persisting well up beyond the region of larger leaves.

The lower a branch arises on the axis, the more leaves it bears before flowering, so that on both main and lateral axes the same number of leaves tends to supervene between root and flower.

When the apex of the main axis produces a flower, this is followed in sequence by flower development upon the highest branch and so progressively down the plant, so that "flowering radiates from the upper pole of the plant". Branching, however, is stimulated by vegetative growth from below while the upper pole functions by checking growth (when apical growth passes into carpel development), whereupon the vegetative effort is directed into other buds.

The author has since communicated to the *Proceedings of the Linnean Society*, November, 1941, the results of a statistical study of meristic variation in the flowers of the same species. This has led him to suggestions as to the influences (possibly hormonic) at work in the production of cyclic whorls. Isomery is traced to the uniform dispersion of such influences, possibly along main lines of contact, the parastichies, while variations in length of plastochrone are then thought to separate the various whorls.

FITNESS FOR MILITARY SERVICE IN THE UNITED STATES

LEONARD G. ROWNTREE, chief of the U.S. Medical Division, Selective Service, explained the function of this Service and described some of the results at a meeting of the American Philosophical Society on November 21–22.

Selective Service is charged with the procurement of men for the U.S. Army; more than 17,000,000 men had been registered and more than 2,000,000 examined, at the time the paper was read.

The Selective Service and Army boards have rejected as unfit for military service approximately 50 per cent of the registrants examined. About 100,000 were rejected for illiteracy; 430,000 were totally unfit for military service, and 470,000 were classified as *I-B*; that is, they might be fit for limited military service were they acceptable under Army standards.

These figures are not to be interpreted as representing 50 per cent invalidism of the registrants examined, or as indicative of 50 per cent illness of the population in general. They simply represent unfitness for military service according to the standard requirements that have been set up by the Army.

These cases of rejections are as follows:

Cause.	No. of cases.	Percentage.
Dental defects	188,000	20·9
Defective eyes	123,000	13·7
Cardiovascular diseases	96,000	10·6
Musculo-skeletal defects	61,000	6·8
Venereal diseases	57,000	6·3
Mental and nervous diseases	57,000	6·3
Hernia	56,000	6·2
Defects of ears	41,000	4·6
Defects of feet	36,000	4·0
Defective lungs, including tuberculosis...	26,000	2·9
Miscellaneous	159,000	17·7
	900,000	100

Because of the relatively poor physical state of 50 per cent of the registrants examined and the urgent need for man-power for national defence, President Roosevelt has suggested that as many as possible of those rejected be rehabilitated. It is estimated that about 200,000 have remediable defects. This work of rehabilitation has been assigned to the Selective Service System. Plans have been formulated, and the work is already under way.

AUSTRALIAN WIND TUNNEL

THE Australian Council for Scientific and Industrial Research has just completed the installation of a wind tunnel at the Laboratory of its Division of Aeronautics. The tunnel is of the closed jet, single return type, the working section being an irregular octagon 9 ft. wide by 7 ft. high.

The shell of the tunnel duct is constructed of ¼-in. steel plate suitably stiffened, with the joints welded to preclude any tendency to leak, and ground flush to minimize surface roughness. The working section, where the pressure is atmospheric, is made of wood to facilitate the erection of models. The cascades or turning vanes, placed at each corner to deflect the air, are also of welded steel, with adjustable trailing edge flaps. Sheet steel, wood and plastic rubber were used to fair and fillet the cascades into the walls of the duct.

The 550-H.P. motor is mounted centrally in the return duct on seven radial supports, designed to remove rotation from the flow behind the six-bladed 13-ft. diameter fan. Six of these radial straighteners serve to lead cooling air into and out of the motor, while the seventh carries the electric cables. An unusual feature is that the section of the duct carrying the motor is separated from the rest of the tunnel. Air-tight joints are made between the flanges on each side by inflated rubber tubes (actually cycle tyre inner tubing).

The tunnel was designed both for research and for tests of aircraft designs, so that the design aimed at the best compromise between high speed (that is, large Reynolds number) and low turbulence. By avoiding expansion through the corner cascades, and reducing the expansion-rate in sections where changes

of shape are occurring, a very efficient design has been achieved. This is indicated by the measured top speed of 300 ft. a second at 550 B.H.P., corresponding with an energy ratio of about 6·0. A honeycomb and settling length have been incorporated to ensure low turbulence.

Speed control of the motor is effected by the Ward-Leonard system, constancy of speed being aided by using a synchronous motor to drive the generator. Calibration tests show the velocity distribution to be within the desired tolerance of ±0·5 per cent of the mean, while there is a pleasing absence of organ notes, whistles or undue noise at any speed. Radiation from the steel shell prevents temperature rises of more than a few degrees during the normal time of a test run.

The balance is situated below the tunnel, and supports the model through three streamlined pylons which pass through the floor of the working section. It has been constructed to measure the lift, drag and pitching moment of the model, but provision is made to add linkages for measuring rolling moment, yawing moment and side force. The maximum forces for which the balance was designed are 1,000 lb. lift and 250 lb. drag. A high order of accuracy has been obtained by careful design and precise workmanship, and the accuracy obtained on calibration was about 1 part in 5,000.

A range of subsidiary equipment has been provided, including a 20 kw. frequency changer for driving small electric motors built into the aeroplane models to rotate the airscrews. Two such motors have been obtained from the United States; they are 3¼-in. in diameter and 5 in. long and each develops 5 B.H.P. at 18,000 r.p.m.

The tunnel and balance were designed by the staff of the Council's Division of Aeronautics, and built in Melbourne by Messrs. Kelly & Lewis. The airscrew driving motor, and its Ward-Leonard control system, were supplied by the English Electric Company, and the fan was also made in England by the Airscrew Co.

GEOLOGY OF LIBYA

IN a lecture delivered before the Geological Society on February 25, K. S. Sandford[1] reviewed existing knowledge of the geology of Libya, his account being in the nature of a sequel to an earlier contribution[2] in which he dealt with the geology of northern Central Africa. The geology of Cyrenaica and Tripolitania is already fairly well known. The Fezzan and the central and southern deserts and oases have been visited by certain scientific missions the publications of which have only recently appeared.

The southern part of the region is dominated by three massifs, each of which extends into adjacent countries: 'Uweinat on the east, Tibesti on the south, and Ahaggar on the west. Each consists of Archæan and other Pre-Cambrian rocks flanked by Palæozoic sediments. Tertiary and later vulcanism has added to the interest of these massifs. Around 'Uweinat there are numerous plugs, craters and lavas; while the other two are crowned by great volcanoes, and rise to heights of about 10,000 ft. The three massifs are separated by sandstone plains which stretch far to the north, sloping very gently in that direction, the sandstones representing continental conditions which appear to have been widespread during later Palæozoic, Mesozoic and Cainozoic times from the French territory on the west, through central Libya, to southern Egypt and the northern Sudan. The sandstones of the plains in turn disappear beneath marine sediments, of Cretaceous and Tertiary age, which represent transgressions of the Tethys, the ancestral Mediterranean, from the neighbourhood of the Gulf of Sirte far to the south. Libya escaped the Tertiary mountain-building movements which formed the Atlas, but the Saharan platform was, nevertheless, warped, upheaved, and broken. The three massifs of the south probably owe much of their differential uplift to these movements. Late volcanic activity is not confined to these highlands, for in central Libya there are vast expanses of volcanic rocks of comparatively recent date.

The Palæozoic sediments, well seen on the flanks of Ahaggar, constitute a long record of marine transgressions from the west. Definitely Silurian beds follow sandstones of doubtful Lower Palæozoic age, and are succeeded by Devonian formations. A temporary retreat of the sea is marked by Carboniferous beds containing Lepidodendron. The final stages of the transgression are recorded by subsequent Carboniferous marine beds, the latest examples of which are interbedded with sandstones containing fossil wood. Marine Permian appears to be absent.

As the sea retreated during the Devonian and Carboniferous, the Palæozoic land of Egypt and the Sudan broadened westwards, and by Permian time Libya was probably elevated and subjected to denudation. Except near the coast of Tripolitania, the sea continued to be excluded from Libya during the Triassic and Jurassic periods. The first important marine transgression from the Tethys was during the Upper Cretaceous, when there may have been a north-and-south strait across northern Africa east of Ahaggar. The second great Tethys transgression carried a Lower Eocene sea southward from Sirte almost to the northern flanks of Tibesti. Middle and Upper Eocene marine beds were deposited over much the same area. In the neighbouring Egyptian marine area, where the Cretaceous is developed on a grand scale, the sea fell back considerably during the Middle and Upper Eocene, and through Oligocene and Miocene times the regression continued in Libya as well as Egypt. Miocene marine beds can be traced from the shores of the Gulf of Sirte through Cyrenaica into northern Egypt. Continental conditions, such as had prevailed since the late Palæozoic, with only occasional interruptions, over much of southern Libya, then extended over the whole territory.

[1] *Abstracts Proc. Geol. Soc.*, No. 1384, 34 (1942).
[2] *Quart. J. Geol. Soc.*, **91**, 534 (1937).

MODERN SCIENCE AND MUSICAL THEORY

THE bearing of modern discoveries in acoustics on musical theory was discussed by Ll. S. Lloyd in a paper read before the Royal Society of Arts on March 4. While the tuning of musical instruments and mathematics have an association that goes back to Pythagoras, it was Helmholtz who first showed, just eighty years ago, that the scientific basis of musical theory must be found in the physiological

and psychological sections of the theory of hearing. Modern acoustical research has completely vindicated, with ample experimental proof, a pronouncement which for Helmholtz was an expression of deep scientific insight. Pythagoras had put the question: "Why is consonance determined by the ratios of small whole numbers?" The tuning of strings formed the basis of the question. Overtones in a musical note had been detected by the human ear. Mersenne recorded four, as occurring at the octave, the twelfth, the fifteenth and the seventeenth of the prime. When it was discovered that a string could vibrate simultaneously, as a whole, two halves, three thirds, and so on, and that the periods of these vibrations fell into a harmonic series: 1, $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{5}$, and so on, corresponding to notes of the scale, the simple numerical relationships were regarded as explaining simple musical intervals. The insistence of Helmholtz that the basis of any scientific theory of music must be sought in the co-operation of ear and brain, aroused considerable opposition.

Helmholtz had made simple experiments with his siren to dispose of the idea that the energy or intensity of a vibration alone determines its loudness. If the energy of the vibrations was left constant, the tone of the siren was faint in the bass but painfully loud in the high treble. The work of Fletcher and Munson[1] has placed this result on a firm quantitative basis over a wide range of frequencies, so that it must now be recognized that loudness depends partly on intensity, partly on frequency, and partly on overtone structure.

The next idea to be given up is that pitch depends solely upon frequency. Fletcher[2] recorded the average judgments, by skilled observers, of the pitches of a series of pure tones produced over a wide range of frequencies with loudness-levels ranging from 40 phons to 100 phons. As a standard of comparison for fixing the pitch, he used a pure tone with a constant loudness-level of 40 phons. At about the middle range of frequencies the pitch may be flattened by a whole tone or more as the loudness is increased. At very high frequencies the pitch becomes sharper, not flatter, as the loudness is increased, but the changes are greatest at lower frequencies. When four harmonics were added to the pure tone, Fletcher obtained only about one fifth as much pitch-change. Pitch therefore is dependent partly on frequency, partly on intensity, and partly on overtone structure.

These facts add considerably to the complexity of interpretation of combinations of notes into chords. Furthermore, Fletcher has shown that if pure tones are sounded together, the pitch of the sound heard may be that of a pure tone below those generated. Musical chords are built not from pure tones but from notes each of which contains several harmonics. The simple numerical relationships got from dealing with pure tones are therefore inapplicable to combinations of musical notes.

Reference was made to the chromatic stroboscope designed by R. Young and manufactured in the United States by C. G. Conn, Ltd., Elkhart, Indiana. When the instrument was used to study the pitch relationships between the notes of well-tuned pianos, surprising divergencies from accuracy were observed. The ear is by no means so exacting about the intonation of the piano as some detailed discussions imply.

[1] *J. Acoust. Soc. Amer.*, **5**, 82 (1933).

[2] *J. Acoust. Soc. Amer.*, **6**, 59 (1934).

FORTHCOMING EVENTS

Wednesday, April 8—Friday, April 10

SCIENCE MASTERS' ASSOCIATION (at Rugby School, Rugby).—Forty-first Annual Meeting.

Wednesday, April 8

Evening—Mr. P. H. B. Lyon: "English in the Science Course" (Presidential Address).

Thursday, April 9

Morning—Prof. M. L. E. Oliphant, F.R.S.: "Recent Practical Applications of Nuclear Physics".

Afternoon—Mr. L. J. F. Brimble: "Human Biology in Education". Annual General Meeting.

Evening—Prof. L. Hogben, F.R.S.: "Science and Citizenship".

Friday, April 10

Morning—Discussion on "Science in Post-War Education", to be opened by Mr. E. G. Savage.

Thursday, April 9—Monday, April 13

BRITISH PSYCHOLOGICAL SOCIETY (at the Municipal Training College, Brighton). Extended General Meeting.

Wednesday, April 8

SOCIETY OF CHEMICAL INDUSTRY (FOOD GROUP) (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 2.15 p.m.—Dr. J. Hammond, F.R.S.: "Animal Production in the Post-War World".

Thursday, April 9

PHYSICAL SOCIETY (JOINT MEETING WITH THE SCIENCE MASTERS' ASSOCIATION) (at Rugby School Science Laboratories, Barby Road, Rugby), at 10.15 a.m.—Mr. C. W. Hansel: "Fundamental Laws and Definitions in Physics", 1: Ohm's Law; 2: Specific Heat and Newton's Laws of Cooling; 3: Mass. Mr. P. Woodland: "The Need for a Permanent Standardization and Guidance Committee for Elementary Physics".

Friday, April 10

ROYAL SOCIETY OF ARTS (INDIA AND BURMA SECTION) (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Diwan Bahadur S. E. Runganadhan: "The Work of Indian Universities".

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Annual General Meeting.

GEOLOGISTS' ASSOCIATION (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. F. J. North: "The Centenary of the Glacial Theory in Britain; Notes on Contemporary Manuscripts and Publications".

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, London, S.W.1), at 5.30 p.m.—Mr. H. E. Dance: "Mechanical Aids to War-time Training".

APPOINTMENTS VACANT

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

HORTICULTURAL ASSISTANT TO THE AGRICULTURAL AND HORTICULTURAL ORGANIZER—The Clerk to the County Council, Shire Hall, Bedford (endorsed 'Horticultural Assistant') (April 11).

LECTURER IN THE DEPARTMENT OF MATHEMATICS—The Registrar, University College, Singleton Park, Swansea (April 22).

ASSISTANT MASTER TO TEACH MATHEMATICS AND ELEMENTARY SCIENCE in the Junior Technical School—The Secretary for Education, Tudor House, Friar Street, Worcester (April 25).

STUDENT-DEMONSTRATOR IN BOTANY—The Principal, Royal Holloway College (University of London), Englefield Green, Surrey (May 1).

UNIVERSITY CHAIR OF OIL ENGINEERING AND REFINING (PETROLEUM TECHNOLOGY)—The Secretary, The University, Edmund Street, Birmingham 3 (May 9).

UNIVERSITY CHAIR OF RADIOLOGY (THERAPEUTIC) tenable at Middlesex Hospital Medical School—The Academic Registrar, University of London, Richmond College, Richmond, Surrey (May 26).

CHIEF METALLURGICAL CHEMIST to take full charge of Steelworks Laboratories, for employment in the East—The Central Register, Ministry of Labour and National Service, Queen Anne's Chambers, Tothill Street, London, S.W.1 (quoting Z446X).

ASSISTANT METALLURGICAL CHEMIST to act as Principal Assistant to the Chief Chemist of a modern Iron and Steel Works—The Central Register, Ministry of Labour and National Service, Queen Anne's Chambers, Tothill Street, S.W.1 (quoting Z447X).

CATALOGUES RECEIVED

Londex Synchronous Time Delay Relay, Type PRL, ranges 2 sec. to 28 days. (List No. 97.) Pp. 2. (London: Londex, Ltd.)

The Wild-Barfield Heat-Treatment Journal. Vol. 4, No. 30-31. Pp. 55-70. (Watford: Wild-Barfield Electric Furnaces, Ltd.)