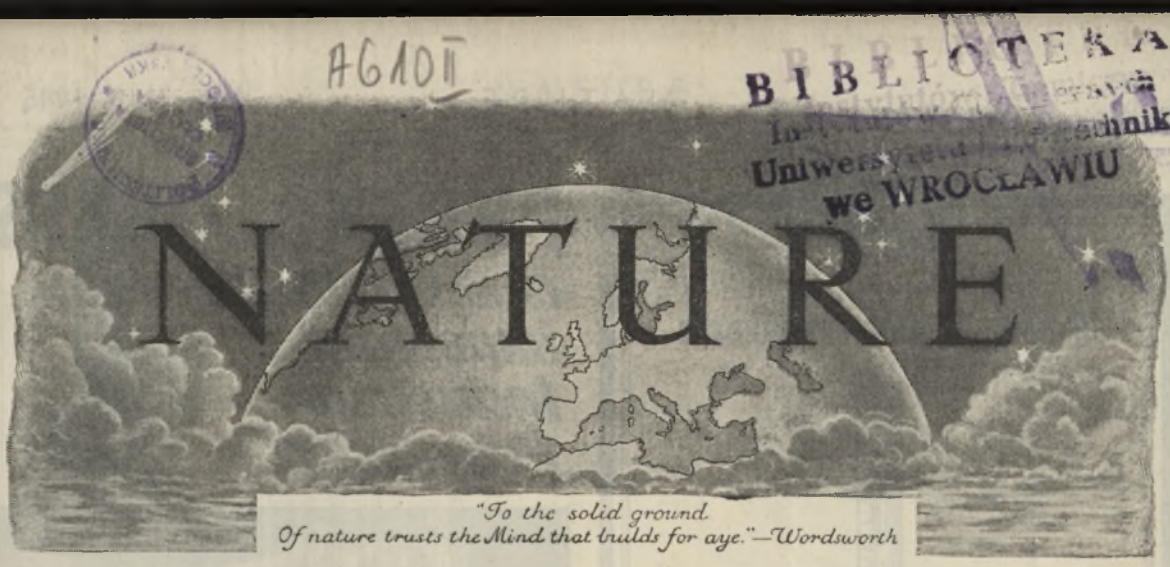

Vol. 156, No. 3955 SATURDAY, AUGUST 18, 1945 ONE SHILLING & SIXPENCE

NATURE

No. 3955 SATURDAY, AUGUST 18, 1945 Vol. 156

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MACMILLAN & CO., LTD.,

ST. MARTIN'S STREET, LONDON, W.C.2.

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Telephone: Temple Bar 1942

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

THE END OF THE SECOND WORLD WAR

THE dramatic collapse of Japan under the pressure of unprecedented air bombardment accompanied by the threat of invasion by overwhelming forces marks the end of the War of 1939–45—the Second World War. More than that, it marks the end of a period extending over some thirty-five years which has witnessed increasing social unrest and suffering, culminating in warfare of an intensity never before witnessed, and physical destruction on an appalling scale. War has now become so terrible, so swift in its march and so indiscriminate in its cutting off of old and young alike, that the greater nations of the world must recoil with horror from the possibility of another major war, lest they court annihilation of whole populations. This is not to say that armed forces will be unnecessary; for so long as man falls short of the ideal in his ethical outlook and practice, there will be differences and disputes, some of which may lead to wars. But it should not be beyond the power of the nations, imperfect as man is, to limit the conflict and promote a swift settlement. Towards this end the United Nations Charter is a first instrument, based on a mixture of idealism and worldly practicability, which can be of prime importance for the future of humanity.

Two events of the immediate past will always be associated with the surrender of Japan to the will of the United Nations. These are the use of atomic energy in the form of a bomb of stupendous destructive power, and the declaration of war on Japan by the U.S.S.R. It is idle to speculate on their relative significance, in that both are the result of carefully prepared plans carried out over a long period; and the fact that they came to fruition almost simultaneously may have been a coincidence. In any event, we are more concerned for the moment with the significance of the release of atomic energy in manageable fashion. This, as we have already pointed out (*Nature*, August 11, p. 153), is a landmark in the history of mankind—it marks the beginning of a new era, an era in which the quality of the work of men of science of the world will not only be of immense importance, but will also be acknowledged as such. It is not suggested that men of science should become, as it were, a ruling caste, to whom all others would defer; they themselves would be the first to dispute any such intention, for their training does not of necessity develop the qualities needed for administration. Rather we would anticipate that they will be expected to take a share in the tasks of government, as they have done during the War, at the direct request of the ruling authority and with a conspicuous success which has been generally acknowledged and acclaimed. Gone, it is hoped, are the days when men of science were regarded as useful standbys, to be called in when things go wrong and speedily relegated to the background after use has been made of their knowledge. But scientific workers must also play their part; they must not allow their preoccupation with their particular interests to make them oblivious to their responsibilities as citizens of

a world which is becoming increasingly dependent on their efforts, and they must maintain their high standard of integrity.

So far as the general outlook is concerned, the present position as regards scientific and industrial research is very little different from that at the close of hostilities in Europe (see *Nature*, May 12, p. 553). Everywhere throughout the world there are shortages due to sheer destruction, to lack of raw materials, to transport difficulties and so on. There are innumerable problems for men of science to tackle, arising out of war-time conditions ; and in addition, there has been a space of six years during which scientific investigation has been very largely diverted from its normal course. Scientific workers will also be called upon in the immediate future in connexion with the control of Japanese scientific and industrial development.

This task will be much the same as in Germany ; for Japan is highly industrialized, and the guidance of her industries on to peaceful lines will require equivalent measures. Nor need the difficulty of a language so different in form and structure from those of Western Europe be regarded as an insuperable barrier. Many educated Japanese are familiar with Western languages, and also there is a small number of European scholars who have studied Japanese history and culture and whose guidance will no doubt be sought ; further, steps have already been taken to train students who show an aptitude for Oriental languages in readiness for such duties as may devolve upon an occupying body. So far as scientific and industrial processes are concerned, there will be little difficulty ; the chemical equation has the same significance, both qualitative and quantitative, in the Far East as in the West, and there is no possibility of shades of meaning ; mathematical symbols are equally definitive throughout the world, whether they are used in purely mathematical work or in connexion with aerodynamics, hydraulics, electrical engineering and other applied studies. Scientific research and industrial practices in Japan have come mainly from European and North American sources and employ the same terms and even the same symbols. Thus it is quite common to find a scientific paper written in Japanese but liberally sprinkled with chemical equations printed in Latin characters with Arabic numerals just as in European practice. Even in biology and geology, scientific terms are usually employed directly without translation, and the binomial system of nomenclature of living organisms is as apparent in papers in Japanese on biological topics as are the chemical equations referred to above. Indeed, the language of science, as it is written in Europe and America, is truly international in form and significance.

In devising means of controlling scientific research and industrial and engineering development in Japan, there seems no reason, as has been suggested above, why it should not follow the main lines laid down for the control of Germany, but with the important proviso that policy will be influenced by the counsel of those who are familiar with the Japanese mode of life and cultural tradition. It would be absurd to attempt control of a country like Japan, which, in spite of the veneer of twentieth century industrialization presented to the casual observer, is steeped in a tradition wholly alien to the outlook of Western Europe and North America, without adequate consideration of these factors.

So much for one specific problem posed by the control of Japan. The distance separating that country from Western centres will present difficulties for the maintenance of even a token occupation force, both as regards supplies and the morale of the men ; and numerous other points for anxious decision must arise.

Many such matters must be regarded as involving what has been termed the tactics of science. We must now revert to the broader question of the grand strategy of scientific and technical development. The controlled release of atomic energy applied in the development of the atomic bomb emphasizes once more the importance of scientific research, and its significance for the progress of knowledge and for the material welfare of mankind. Scientific and technical research has made possible this appalling weapon of destruction, and it will not let the matter rest there. As was pointed out in *Nature* of August 11, the discovery is the culmination of many years of patient and sometimes dangerous investigations, and the fact that it has been developed for the purpose of war is no fault or desire of scientific men as a body. They will therefore wish to push on vigorously with investigations of the mechanism of the reactions involved, and with their adaptation to the peace-time needs of man. This may mean many years of labour —perhaps as many as have passed since the idea of atomic disintegration became more than the philosopher's dream. But they will not be deterred.

Nevertheless, means must be found of financing such investigations, which from their very nature can claim the interest only of those concerned with long-range developments ; and present indications are that much elaborate and costly equipment on an engineering scale will be necessary. Only Governments or national institutions are likely to be in a position to respond to the requirements of research of this character in atomic physics. All this points towards the same conclusion as was reached in considering the moral aspects of the discovery of the regulated release of atomic energy, namely, it is a responsibility of Governments. The possibilities for good or evil are of such magnitude that individuals cannot fairly be entrusted with their exploration ; similarly, none but Governments are likely to be able to provide the continuous expenditure necessary for development. Moreover, there must not be parsimony in the matter, as so often occurs when results do not immediately accrue ; there must be faith in the outcome even when times are difficult and retrenchment seems inevitable. President Truman's request to Congress for provision for such research, and the British Government's announcement of its desire for collaboration, are therefore welcome moves ; the Canadian Government is also to push on with investigations. The keynote in this matter, as in other affairs, is research, and yet more research. Research can be speeded up in time of national emergency, as

we have recently seen, and now it is a matter of world emergency. Coupled with research there must be education, in the broadest sense, as has often been emphasized in these columns, so that nations may appreciate their responsibilities to their neighbours, who are now all the peoples of the world.

But we would conclude on a note of hope for the future. The end of the war with Japan marks the total defeat of aggression in the East and the West. To achieve it the freedom-loving nations have combined their forces, and incidentally voluntarily surrendered much of their freedom as sovereign States, while individual men and women have submitted to government largely by order from higher authority. It is not desirable or possible that such loss of democratic rights and privileges should continue; but it should be quite clear that the active association of the Great Powers must go on, in order that the world may recover from the disaster which has overtaken it. The United Nations Charter is a first step in this direction, on which it must be hoped that the nations of the world will build a structure enabling mankind to go forward in peace and prosperity to a new world order.

JOHN TYNDALL

Life and Work of John Tyndall

By A. S. Eve and C. H. Creasey. Pp. xxxii+404+25 plates. (London: Macmillan and Co., Ltd., 1945.) 21*s*. net.

JOHN TYNDALL was among the greatest masters of experimental demonstration that the world has seen. Davy, Faraday, Dewar and Bragg stood high in this category, and it is noteworthy that all these prepared and produced many of their demonstrations at the Royal Institution. In this particular direction Tyndall stood as high as any of them. It is not easy to realize how much of what is now the commonplace of lecture illustration in the physical sciences became so through him. He gave much thought and study to producing dramatic effects; indeed, stories were current which caricatured this aspect of his lectures, though it is difficult at this distance of time to judge whether any credence should be given to them. However that may be, there can be no doubt about the eagerness with which he was listened to, both in Great Britain and in the United States, nor about his great skill in carrying a popular audience with him.

The picture has, of course, another side. Some scientific men, among whom P. G. Tait was conspicuous, seem to have been much irritated by Tyndall's popular reputation, and hinted more clearly than good manners should have permitted that he verged on being a charlatan. I have looked over several of his books to try and judge for myself whether there was any real justification for this, but I cannot find that there was any.

Though I can remember Tyndall in the flesh, I was too young at the time to form any judgment of my own. The late Lord Rayleigh, however, who knew him well, thought highly of Tyndall's scientific work, and expressed himself more emphatically than was usual with him in the sense that Tyndall's critics were entirely mistaken in their estimate. He thought, however, that they had had their effect on Tyndall by putting him on the defensive.

The controversy about the doctrine of energy was one of the points on which Tait was most emphatic. It is not doubtful, I believe, that J. B. Mayer was the first to give a numerical value for the mechanical equivalent of heat, and that his value was substantially correct. If these facts are admitted (and I have not seen them denied), the plain man will not easily be convinced that Mayer's contribution was worthless. Yet Tait and also Kelvin were inclined to take this line. There was no doubt a serious flaw in Mayer's argument; but it may well be held that those who enunciate new and important results *which prove to be right in substance* should not be judged by the criteria which would be appropriate in marking an elementary examination paper a generation later. Tyndall, moved by a sense of justice, argued strongly in Mayer's favour, and I believe that the view which he took has been generally adopted in Germany; Helmholtz at least seems to favour it. Tait was probably right in assuming that Tyndall knew little of the more abstruse questions of mathematical physics: but it is not apparent that he ever professed to do so, and, after all, one cannot do everything. Tyndall, in spite of ill-health, and with no initial advantages, achieved a great deal for science in many directions. We should be grateful for what he was, rather than critical of what he was not. This book fills, at long last, a gap in the history of British science in general, and of the Royal Institution in particular.

The reviewer has read again, after an interval of more than fifty years, several of the essays contained in Tyndall's "Fragments of Science", and comes away with the impression that they have stood the test of time remarkably well. Phrases are occasionally met with which grate unpleasantly on the modern scientific ear, particularly where Tyndall deals with the electric arc, and the design of the dynamo; but if it is remembered that at the time the ampere and the volt had scarcely been defined, still less were any direct-reading instruments available for measuring currents and electromotive forces, this must in fairness be put down to the contemporary state of electrical science rather than to any shortcomings on the part of their author. By reading rather out-of-date accounts of scientific advances, one gets an insight into where the difficulty lay which is of great historical interest, and which fills a gap which can scarcely be filled otherwise. It is not at all easy for any student of scientific history to appreciate a difficulty which is no longer felt. In this matter of the efficiency of the dynamo, Tyndall's generation certainly felt at the back of their minds that there was some inherent obstacle to its working at a high efficiency. There is, of course, in fact no such obstacle, and it is very hard now to trace why they thought that there was. It is not suggested that Tyndall particularly countenanced this idea, though in some passages he seems to attach a theoretical importance to the internal resistance of the machine which reads oddly to-day.

It is difficult, coming to another aspect of Tyndall's writings, at this distance of time and in the intellectual atmosphere of the present day, to understand the storm which was aroused by his Belfast address to the British Association in 1874. A profound effect was provoked by that address, and the passage which was most resented has often been quoted—it runs thus: "The impregnable position of science may be described in a few words. We claim, and shall wrest from theology the entire domain of cosmological

theory. . . ." The almost equivalent statement that "The Bible was not meant to teach science" might now be heard without surprise from any evangelical pulpit.

There can now be few, if any, survivors of those who hung on Tyndall's words at the Royal Institution and who would have been the most eager readers of this book. A series of unfortunate circumstances led to its late appearance. Chief among these, it must be confessed, was the very dilatory way in which Mrs. Tyndall dealt with the materials which were in her hands. In theory it had been her aim to devote her life to erecting this memorial to his memory, and as she survived him for many years, living a quiet life in the country, it would not seem at first sight that the opportunity to carry out this purpose was lacking: but misfortune seems to have dogged the project. Mrs. Tyndall began with an exaggerated notion of the scale on which such a book should be written. She was not prepared to reject anything; and under these conditions the amount of material proved unmanageable. Further, when it became obvious that she would never complete the work, she would not reconcile herself to putting the material in other hands, or to parting with the detailed control of how it was to be used. The result was that nothing effective was done while Mrs. Tyndall was alive. She provided, however, for its being accomplished by others, and her nephew, Mr. Granville Proby, has seen to the ultimate and satisfactory fulfilment of her wishes. He placed it in the hands of Prof. A. S. Eve, the biographer of Lord Rutherford, and when Eve was unable to continue, it was finally finished by Mr. C. H. Creasey.

As the result of this long delay, the book will not now be read by those whose personal memories would have illuminated the subject, but the story has at least been satisfactorily recorded for the present and future generations. RAYLEIGH.

BESSEL FUNCTIONS

A Treatise on the Theory of Bessel Functions

By Prof. G. N. Watson. Second edition. Pp. viii+804. (Cambridge: At the University Press, 1944.) 60*s*. net.

THE memoir in which Bessel, the astronomer, examined in detail the functions which now bear his name was published in 1824, and was the outcome of his earlier researches concerning the expression of the radius vector in planetary motion.

The ordinary linear differential equation of the second order

$$x^2 \frac{d^2y}{dx^2} + x \frac{dy}{dx} + (x^2 - \nu^2)\, y = 0 \quad . \quad . \quad (1)$$

is known as Bessel's equation of order ν. Any solution of this equation is a Bessel function of order ν. Neither x nor ν is necessarily restricted to real values.

If in (1) we write $u = y\sqrt{x}$, the corresponding equation for u becomes

$$\frac{d^2u}{dx^2} = -\left(1 + \frac{\frac{1}{4} - \nu^2}{x^2}\right) u$$

which for large values of x tends to the simple harmonic equation

$$\frac{d^2u}{dx^2} = -u, \quad . \quad . \quad . \quad . \quad (2)$$

the solution of which is well known to be of the form $u = A \cos x + B \sin x$, so that for large values of x, any Bessel function y may be expected to behave like $(A \cos x + B \sin x)/\sqrt{x}$. Moreover, just as the general solution of (2) is expressed in terms of the familiar special solutions $\cos x$ and $\sin x$, so the general solution of (1) is expressed in terms of any two linearly independent special solutions, for example, the particular Bessel functions denoted by $J_\nu(x)$, $Y_\nu(x)$ where

$$J_\nu(x) = \sum_{m=0}^{\infty} \frac{(-1)^m \left(\frac{1}{2}x\right)^{\nu+2m}}{m!\ \Gamma(\nu + m + 1)}$$

$$Y_\nu(x) = \frac{J_\nu(x) \cos \nu\pi - J_{-\nu}(x)}{\sin \nu\pi} \quad . \quad . \quad . \quad . \quad (3)$$

When ν is an integer n, $Y_n(x)$ is defined as the limit of $Y_\nu(x)$ when $\nu \to n$. These functions are known as Bessel functions of the first and second kinds respectively. For large values of x they approach the respective values

$$\left(\frac{2}{\pi x}\right)^{\frac{1}{2}} \cos\left(x - \tfrac{1}{2}\nu\pi - \tfrac{1}{4}\pi\right), \quad \left(\frac{2}{\pi x}\right)^{\frac{1}{2}} \sin\left(x - \tfrac{1}{2}\nu\pi - \tfrac{1}{4}\pi\right), \quad (4)$$

and this parallelism with the cosine and sine is one of the three reasons which the author adduces for adopting $Y_\nu(x)$ as the canonical function of the second kind. Moreover, just as the solutions $\cos x$, $\sin x$ of (2) are connected by $\cos x = \int \sin x dx$, so we have the relation

$$Y_\nu(x) = \frac{2}{\pi} J_\nu(x) \int \frac{dx}{x J_\nu^2(x)}$$

between the functions (3), a suitable value of the constant of integration being presumed in each case. The forms (4) also show how to obtain approximate values for the large zeros of the functions (3).

The zeros of Bessel functions are important both for the theory and for the physical applications. Let $j_1, j_2, \ldots$ denote the positive zeros of $J_\nu(x)$ in ascending order of magnitude. Then

$$\int_0^1 x J_\nu(x j_r)\, J_\nu(x j_s)\, dx = \tfrac{1}{2}\, J_{\nu+1}(j_r)\, J_{\nu+1}(j_s)\, \delta^{rs}$$

where $\delta^{rs} = 0$ or 1 according as $r \neq s$ or $r = s$. This leads to the Fourier-Bessel expansion of a function $f(x)$, provided such an expansion is possible, in the form

$$f(x) = A_1 J_\nu(x j_1) + A_2 J_\nu(x j_2) + \ldots$$

where

$$\tfrac{1}{2}\, A_r J^2_{\nu+1}(j_r) = \int_0^1 x f(x) J_\nu(x j_r) dx,$$

a method entirely analogous to that of Fourier's expansion.

Of great importance in mathematical physics are the modified Bessel functions $I_\nu(x)$ and $K_\nu(x)$ which are certain particular solutions of the equation which arises from (1) when ix is written for x. Here, for example, if x is real and positive

$$I_\nu(x) = e^{-\frac{1}{2}\nu\pi i} J_\nu(ix).$$

Kelvin's functions $\mathrm{ber}\, x$ and $\mathrm{bei}\, x$, which have applications in alternating current theory, are the real and imaginary parts of $I_0(x\sqrt{i})$.

In applied mathematics Bessel functions find their use in a wide field, of which a few instances can be

cited in general terms: in hydrodynamics, to wave motions, vortices, viscous flow; in electricity, to microphones, transmission lines, skin currents, waveguides; in elasticity, to isotropic rods, torsional vibrations; in mechanics, to cylindrical rods, vibration of membranes, oscillating chains. Indeed it was in connexion with this last problem that Daniel Bernoulli in 1738 actually obtained an infinite series which is the expansion of a Bessel function, and noted that it had an infinite number of zeros.

One reason at least will make clear why numerous physical applications are to be expected. Laplace's equation in cylindrical co-ordinates (r,θ,z) assumes the form

$$\frac{\partial^2 V}{\partial r^2} + \frac{1}{r}\frac{\partial V}{\partial r} + \frac{1}{r^2}\frac{\partial^2 V}{\partial \theta^2} + \frac{\partial^2 V}{\partial z^2} = 0.$$

If we seek to satisfy this by $V = R\Theta Z$, where R, Θ, Z are respectively functions of r, θ, z alone, we find that $\Theta = e^{\pm i\nu\theta}$, $Z = e^{\pm ikz}$, and if $u = kr$,

$$u^2\frac{d^2R}{du^2} + u\frac{dR}{du} + (u^2 - \nu^2)R = 0,$$

which is Bessel's equation. Thus, Bessel functions play the same part in potential problems relating to cylindrical boundaries (for example, the flow of heat) as do Legendre's functions in problems relating to spherical boundaries.

In Prof. Watson's treatise, which is a monument of erudition and of its often too rare accompaniment, clear exposition, we have a rigorous mathematical treatment of all types of Bessel functions, their properties, integral representations, asymptotic expansions, integrals containing them, allied functions, series, zeros, tabulation, together with extensive numerical tables. To quote from the preface to the first edition, "The book has been designed with two objects in view. The first is the development of applications of the fundamental processes of the theory of functions of complex variables. . . . The second object is the compilation of a collection of results which would be of value to the increasing number of Mathematicians and Physicists who encounter Bessel functions in the course of their researches. . . . While my endeavour has been to give an account of the theory of Bessel functions which a Pure Mathematician would regard as fairly complete, I have consequently also endeavoured to include all formulæ, whether general or special, which, although without theoretical interest, are likely to be required in practical applications; and such results are given, so far as possible, in a form appropriate for these purposes." This was written in 1922, and apart from a few minor corrections, the second edition is a photo-reprint of the first, the author stating that he was unprepared to undertake the rewriting of about half the book to the detriment of other activities. With this view we may sympathize, but at the same time we must regret that Prof. Watson has not taken the opportunity to include at least one new chapter on the application of Heaviside's operational calculus or its equivalent, the Laplace transform, to Bessel function theory, which has been so largely developed in the intervening twenty years. His unrivalled powers of exposition would have made this a welcome addition. Nevertheless, the book is one which nobody interested in Bessel functions can afford to ignore, or should even wish to do so.

L. M. Milne-Thomson.

FAMILY STUDIES IN TUBERCULOSIS CONTROL

Familial Susceptibility to Tuberculosis

Its Importance as a Public Health Problem. By Dr. Ruth Rice Puffer. (Harvard University Monographs in Medicine and Public Health, No. 5.) Pp. xi+106. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1944.) 2 dollars.

THE author of this excellent little book is a member of the Williamson County Tuberculosis Study, Tennessee; her object is to assess the significance of two factors in the development of tuberculosis: first, familial susceptibility; second, exposure to infection.

A review of past and present literature amply shows that many writers regard the susceptibility of the individual—the 'soil' as it is often called—as a factor equal in importance with infection in the causation of tuberculosis. At the same time it is generally agreed that if the infecting dose is heavy individual susceptibility is of much less importance. It is pleasant to read again the call that Karl Pearson made for sober reflexion, when, after Koch's discovery of the tubercle bacillus, popular opinion swung violently over to infection as the chief cause of tuberculosis with resulting complete neglect of all other factors. We shall do well to remember the need for clear thinking at the present time when so many new discoveries are being made.

The author goes on to show that many regard familial susceptibility as a factor in the development of several other diseases; but it seems unnecessary in a book of this size to devote nearly a whole chapter to discussing this in relation to leprosy, rheumatic fever, poliomyelitis, and diabetes. There is a useful account and discussion of animal experiments that show evidence of familial susceptibility; these are obviously of great importance. But it is surprising, in so wide a review of the literature, that mention is not made of immunization against tuberculosis with living attenuated bacilli (B.C.G.). Wells's experiments on immunizing animals with vole acid-fast bacilli also deserve mention, especially since there has been a recent revival of interest in attempts to immunize actively against tuberculosis (leading article, *Brit. Med. J.*, p. 716; December 14, 1943).

In discussing the analysis of the data presented, the author stresses the need for a suitable tuberculosis classification such as Opie's, which is used. This classification is given in detail as an appendix to the book. Frost's statistical method ("person—years of life experience") as applied to morbidity- and mortality-rates is most suitable in work of this kind. Full details of this method, which is an adaptation of life table procedures, are given in an appendix to the book. There are many advantages in using the 'index case' instead of the 'primary case', the 'index case' being that of the individual whose medical history of known or suspected tuberculosis directs attention to his family or associates. Data from the Williamson County Study that concern siblings, consorts, parents, and children of 'index cases' are analysed and discussed in comparison with similar studies by other workers. Interesting work on twins is discussed, and figures are quoted to show that tuberculosis-rates are higher in the co-twin of uniovular twins than of binovular twins. But it must be remembered that uniovular twins are of the same sex and are as a rule very closely associated.

An interesting explanation is given for the decline of the tuberculosis death-rate: when the rate is high more females die than males; but as the rate falls the sexes are equally affected, as in England about 1860; thereafter the male death-rate begins to exceed the female. This, it is said, is due to the deaths of females during the child-bearing period and the result is a reduction of the number of susceptible families. This point is well worth remembering when assessing the value of control measures over a number of years.

More light is thrown on the vexed question of tuberculosis in consorts. It is known that a large proportion of exposed consorts do in fact develop the disease, but that others remain well. The family history of exposed consorts shows that those whose families are tuberculous show a higher incidence of the disease than those whose families are free from tuberculosis. It is emphasized that to know the true picture for children they must be followed up after they leave the home.

In a concise summary the author outlines how better methods of control could be instituted by a more comprehensive case-finding campaign based on information about those persons known to have tuberculosis and about susceptible families. Surprisingly, mass miniature radiography is not discussed; it is by this method above all others that much wider groups can now be examined than ever before.

Although it offers nothing outstanding in the way of new discoveries, this book succeeds in its aim of throwing more light on the problems of susceptibility to tuberculosis, and it includes a really remarkable amount of useful information in just over a hundred pages. The volume is well written and presented, the graphs and tables are clear and easy to understand, and a full bibliography is included. All concerned in the control of tuberculosis—public health officers, tuberculosis officers, health visitors, social workers general practitioners, and medical research workers —should find much to interest them in its pages.

THE CHILD'S BLOOD IN HEALTH AND DISEASE

Atlas of the Blood in Children

By Dr. Kenneth D. Blackfan and Dr. Louis K. Diamond. Pp. xiv+320 (70 plates). (New York: Commonwealth Fund; London: Oxford University Press, 1944.) 66*s*. 6*d*. net.

ALTHOUGH we have long been accustomed to coloured illustrations in text-books and monographs on hæmatology, we find in this "Atlas of the Blood in Children" something above the ordinary not only in its extent, but also and more especially in the happy combination of faultless artistry and perfect colour-printing. The very slight variation in colouring due to the routine use of Wright's stain in place of those more commonly used in Great Britain, namely, Leishman or Giemsa, does not detract in the slightest from the value of the seventy plates used to illustrate the important features of the blood pictures of more than five thousand cases examined and catalogued by the authors in their special hæmatological laboratory in the Infants' and Children's Hospitals, Boston. A special point is made of the fact that the "Atlas" is not intended as an exhaustive treatise on the variations in the blood in diseases of children, but represents only conditions with which the authors have had close personal experience. This will explain some omissions, and also the apparently undue stress laid on diseases seldom seen in Britain, such as Mediterranean anæmia and sickle cell anæmia.

The text deals with the hæmatology of childhood in five main sections: the blood cells; anæmias; the leucocytes in disease; the leukæmias; the platelets. The first section has much valuable information, but will be spoilt for most British readers by its use of the term 'megaloblast' for the parent cell in the normal development of the red blood corpuscles. Once the necessary mental adjustment has been made to allow for this divergence from hæmatological nomenclature in Britain, the rest of this, and of the succeeding section on the erythrocytes in anæmia, can be read with real pleasure and much profit. The authors have adopted a purely morphological basis for the classification of the anæmias, which, though somewhat outdated, lends itself admirably to a treatise in which pictorial representation of the blood as seen in stained films is the *raison d'être* of the publication. The inclusion of a separate group of "Anaemias often associated with Jaundice", though inconsistent with this classification, has its points clinically.

The section on "The Leucocytes in Disease" has much valuable observation condensed in the few pages devoted to it. Particularly valuable are the full descriptions of significant blood pictures in pulmonary tuberculosis and infectious mononucleosis. In the section on leukæmia there is perhaps an over-elaboration of clinical types and too facile a dismissal of the value of marrow puncture. The last section, on the platelets, is adequate, but contains an inexplicable confusion between Henoch's and Schönlein's purpura. This lapse will certainly cause the authors no heart-burnings, since they rightly dismiss these subdivisions of purpura as of little real significance.

The "Atlas" and its text are obviously intended primarily for the practising pediatrician and his hæmatologist. Full case histories of selected illustrative examples of the various disease states are included but are not overdone. Commendable restraint is also exercised in the details of laboratory data, particularly in the matter of descriptions of the blood picture presented, the very realistic coloured plates of blood films taking the place of these descriptions. There is little attempt at discussion of debatable theories and hypotheses, and if this does at times result in the apparently uncritical acceptance of views still *sub judice*, it certainly leads to brevity. There is a healthy insistence on the practical in both treatment and investigation, and the dangers and advantages of blood transfusions receive frequent and carefully considered mention. The sequence of the illustrations follows that of the text, and each plate is faced by an outline drawing on which the characteristic or abnormal cells are numbered for detailed reference in the descriptive legends. The printing is excellent, the style easy and the indexing satisfying.

This joint production by the clinician, the laboratory hæmatologist and the artist is one which goes a long way towards filling a serious gap in the bookshelves of pediatricians and clinical pathologists, and can be warmly commended not only to these but also to all who have any contact with hæmatology in general or with children in any branch of medical practice.

THOS. B. DAVIE.

A HITHERTO UNPUBLISHED LETTER OF ISAAC NEWTON

THE Royal Society recently received, on indefinite loan from its present owner, a hitherto unrecorded autograph letter of Isaac Newton. The letter is a long one, it has an intrinsic interest for the history of science, it is in a remarkably good state of preservation and its authenticity is established with unusual completeness. It was written in 1677 from Cambridge to the Hon. and Rev. Dr. John North, then living in London, but later Master of Trinity College, Cambridge. The present owner of the letter, Mr. Roger North, of Rougham, King's Lynn, Norfolk, who has placed it in the custody of the Royal Society, makes the very probable suggestion that the "new Treatise of Musick", with which the letter deals, was "A Philosophical Essay on Music", by Francis North, Lord Guilford, to whose brother the letter is addressed.

The letter is written on both sides of a sheet of paper measuring about 15½ in. by 12 in., in a very neat and easily legible hand, which is certainly that of Newton. One half of one side was left blank, so that on folding for postage it could be addressed without envelope. On one of the blank oblongs left by this folding, the letter has been further identified by endorsements written by (1) Roger North, son of the Hon. Roger North of Rougham and nephew of Dr. John North, the recipient; and (2) Frederick North, great-grandson of (1) and great-grandfather of the present owner, Mr. Roger North of Rougham. The fine state of preservation is explained by the fact that, as Mr. North informs me, the letter had been kept continuously between the leaves of a folio volume in the family library, until he recently had it framed between plates of glass.

The scientific world is indebted to Mr. North's generous thought, which has now made the letter available for study by placing it in the Royal Society's library. The publication of the following text of the document will, meanwhile, make its substance available to the readers of *Nature*.

H. H. DALE.

Cambridge Apr 21.1677

Sr

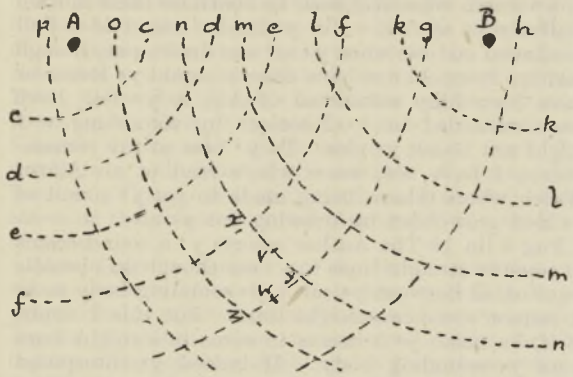
The esteem you express of my judgment I must impute to yor goodness who are willing to make y• best of every thing. Yet since it is yor desire to have my opinion about this new Treatise of Musick, I shall give it you, though perhaps not so largely as you may expect, there being some things which I cannot speak positively to for want of experiments & skill in Musick.

Pag 5 lin 14 & pag 6 lin 30, the Author asserts y‡ sound is produced in y• Torricellian vacuum, & thence seems to collect y‡ y• medium of sound is not y• grosser Air but some subtiler aerial fluid of a middle nature between y‡ Air & AEther, wch can penetrate glass & other gross bodies. But it is to be suspected y‡ this experim‡ of y• Torricellian Vacuũ holds only when y• glas is not well emptied of Air. For Mr Boyle (Exp‡ 27) repeating it w‡h a watch hung in his Receiver, found that as y• receiver was more & more emptied, y• noise made by y• Ballance wheel grew fainter & fainter till at last it was not heard at all though y• handle & wheels of y• watch were still seen to continue their motion as freely as at first. Yet y• louder sound of a Bell continued audible when y• air was drawn out, though perhaps it would not have done so could y• Receiver have been fully exhausted of Air, & y• Bell have been susteined in y• Receiver by something w•h might not touch y• glas. To y• best of my remembrance I have also some where read of an Alarm Watch whose Alarm being made to go, y• sound of y• Bell grew faint by drawing out y• air.

Pag 5 lin 18 The Author asserts y‡ a sound seems to come in streight lines to y• ear though an obstacle be situated between y• ear & y• sounding body so y‡ it cannot come in streight lines. But this I doubt of if, he mean y‡ it seems to come in streight lines from y• sounding body. If indeed y• interposed obstacle be not too gross & compact, suppose a glass window or thin wall of wood or mortar, y• air may by shaking it propagate y• sound through it, & then y• sound will be heard in a streight line from y• sounding body: but if y• obstacle be massy, suppose a very steep & high hill or a sollid high wall of brick or stone, I am apt to think y• sound will seem to come from y• top of y• Hill or Wall rather then in a direct line from y• sounding body behind it. And some such diverting of sounds I have observed occasionally, in walking on a street close by a single house whilst bells were ringing on y• other side. The house to y• best of my remembrance had no windows on that side next me & y• sound of y• bells seemed to come from y‡ end of y• house w•h I was nearest to, though y• bells were directly behind it so in a Room of stone walls w‡h but one window, the sound will seem to come from y• window though y• sounding body without lye not that way.

Pag 8 lin 14 The Author affirms y‡ where y• vibrations of two sounding strings are equal, they will work one another to a coincidence or synchronism, & on this position grounds all his discours of concords & discords, affirming y‡ unisons alway strike y• ear together, Octaves at every other puls of y• Treble, fifts at every 3d pulse &c. But it seems otherwise to me for though y• pulses of y• strings should reduce one another to a synchronism, yet those of one string will strike y• ear sooner or later then those of y• other, accordingly as y• ear is more or less near to one string then to y• other.

Since sounds are not propagated in a moment, y• pulses must not be supposed to extend each of them at once from y• sounding body to y• ear in such manner y‡ all y• air in that interval be moved together first forward & then backward, & so forward & backward again so long as y• sound lasts: but y• pulses are rather to be conceived like so many spherical concentrick waves whose center is y• sounding body & w•h arising continually from y‡ center dilate & flow on from thence with that swiftness we find sound propagated till they arrive at y• ear; new pulses from y• center continually succeeding them after y• manner of undulations made by throwing a stone into water. Let therefore A & B represent two sounding bodies of like tones, c,d,e,f, &c y• pulses continually propagated from A; & k,l,m,n, &c y• pulses propagated from B. And if y• ear be placed at x, or y, or z, or any place where y• pulses at any time intersect, they will strike y• ear at y• same time, but if it be placed between x, & y suppose at v, y• puls xn w•h comes from y• Body B will strike it in y• intervall of y• pulses xf & yg w•h come from y• body A. And the like will happen if



y° ear be placed between y & z as at w, or in any pulse of one body & between two pulses of y° other. So that y° ears of two men or y° two ears of y° same man according to their position from y° sounding bodies may be struck the one at once y° other successively by y° pulses, & yet in all positions of y° ear y° sounds & their harmony are heard y° same. The like of bodies tuned to a fift or any other Concord. Seing therefore y° pulses of two sounds may at y° same time strike one ear both together & another ear alternately & yet do exhibit y° same concord to all ears, it follows 1st that concords arise not from y° coincidence of pulses at y° ear nor have any dependance on such coincidences, & 2^{dly} that unisons are rather a harmony of two like tones then a single tone made more loud and full by y° addition as y° author would have it, p.8.1.20.

The explication of y° sound of whistles pag 12 is very ingenious, but I fear not altogether substantial. Yet for want of apposite experiments I can neither sufficiently confute it nor confirm any new Hypothesis.

The discours also about breaking of Tones into higher notes seems very ingenious & judicious, but I want experience to discern whether altogether solid, & much more do I want experience & skill to enable me sufficiently to judge of what follows about Tunes, y° scale of Music, & consort; this requiring a combination of musical & mathematical skill, & therefore I shal content my self wth having thus far animadverted upon y° Author.

I am much obliged to you for giving me notice of the objection made against my notion about colours. But y° experiment succeeds otherwise then tis reported. If you place your eye where y° blew light falls on y° wall so y^{t} a by-stander see your eye of a blew colour you will at y° same time see y° Prism of a blew colour; and so if you place you eye in y° red light you will see y° Prism red. What colour a By-stander sees fall on yo^{r} eye you will see at y° Prism: as I can affirm by iterated experience.

The last week I called at yo^{r} Lodgings & hope ere long to have an opportunity to wait on you again. In y° meane time I rest wth my thanks to you for yo^{r} kind acceptance of my former Letters

Yo^{r} humble Servant
& honourer
Is. Newton

For the R^{d} & Hon^{ble}
Dr North, to be left
at Mr Pawley's at
the Bible in
Chancery Lane
London

ENZYME ACTIVITY AS A FACTOR IN INSECT PHYSIOLOGY AND TOXICOLOGY

By Dr. H. HURST
Department of Colloid Science, Cambridge

FOR many years the search for new insecticides has proceeded on the working hypothesis that toxicity is related to highly specific molecular configurations in the insecticide molecules. An excellent example of the analytical approach used by the chemist has been provided recently by Läuger, Martin, and Müller, who have made an exhaustive and critical examination of the constitution and toxic action of natural insecticides, such as pyrethrins and rotenone, and in particular, the new synthetic insecticide D.D.T. (α,α-bis-(4-chlorphenyl)-β,β,β-trichloroethane)[1]. But before any evaluation of insecticidal activity may be made in terms of specific group concepts, it is necessary to take into account some less specific dynamic factors in activity. In this connexion, the carrier medium in which an insecticide is dissolved may alter the permeability of the insect cuticle and so modify access of insecticide to the internal tissues[2].

The importance of this rate factor in access of insecticide becomes apparent if we make the valid assumption that insecticidal activity is associated with some disturbance in the chain of consecutive vital processes which regulate the dynamic balance in internal tissue metabolism. If gross biological responses, such as paralysis or death, can be identified more specifically with changes in enzyme activity, a step forward will have been taken towards the elucidation of the more interesting anomalous systems in insect toxicology where there is no apparent coincidence between molecular structure and insecticidal activity.

These concepts will be illustrated in the present article, where an attempt is made to define the biophysical factors which influence the uptake of insecticide by the insect cuticle and internal tissue receptors. Some new factors in insecticidal activity will be described, depending on the discovery that phenoloxidase activity in the cuticle and sensitive tissue receptors* may be greatly modified by the selective environmental influence of the structural components associated with the enzymes *in vivo*. Narcosis, or knock-down action, may involve the indirect blocking of enzyme activity by the adsorption of insecticide on the protective lipo-protein tissue components. Lethality usually involves an irreversible increase in phenoloxidase activity owing to the displacement of protective lipoid from the tissue receptor complex. This stage is accompanied by the accumulation of toxic quinonoid metabolites in the blood and tissues, and is characteristic of the lethal action of insecticides and simpler fat-soluble drugs. Relative susceptibility of insects to contact insecticides depends partly on cuticle permeability, but more fundamentally on the stability of the internal tissue receptors which regulate the internal balance in oxidative metabolism.

Apart from differences in molecular structure, insecticides as a class are fat-soluble. The access of contact insecticides involves the uptake and storage of insecticide by the outer lipophilic epicuticle layer

* The term 'receptors' is frequently used in pharmacology to indicate the sites of action in biological systems with which drugs are supposed to combine or exert specific actions.

of the insect cuticle. In blowfly larvæ, such as *Calliphora erythrocephala*, or *Phormia terrænovæ*, the soft cuticle is hydrophilic, and the receptor surface of the epicuticle is heterogeneous, consisting of a mosaic arrangement of lipoid and protein receptor patches[3]. Even where the cuticle is waxy, as in *Tenebrio molitor* larvæ, the presence of protein receptors in the epicuticle may be demonstrated by means of protein tanning reagents. Pryor[4] has stressed the analogy between the natural tanning of insect cuticle and the tanning of gelatine by *p*-benzoquinone, but whereas the tanning of insect cuticle by *p*-benzoquinone takes place more rapidly in organic fat solvents than in aqueous substrates, this selective carrier activity is not shown with lipoid-free proteins such as gelatine. Fat solvents which increase the permeability of the cuticle to water-insoluble insecticides, such as pyrethrins or D.D.T., also increase the rate of access of *p*-benzoquinone, so that a given concentration of the reactant is more active in an oil than in an aqueous carrier medium[3].

Here we have a clue to the nature of the spatial changes induced in the epicuticle receptors by the fat-solvent carriers, for these changes must increase the permeability of the cuticle both to fat-soluble and to water-soluble drugs. Similarly, the sensitization of the cuticle by fat solvents is associated with an increase in the permeability of the cuticle to water, suggesting a displacement of protective lipoid from the more hydrated receptors[2,5]. Morphologically, the epicuticle receptor system must be consistent with toxicological and physiological behaviour. The lamellar structure of insect cuticle suggests that the plane of orientation of the epicuticle lipo-protein micelles is parallel to the cuticle surface. This is further supported by the X-ray diffraction studies of Fraenkel and Rudall on the chitin-protein crystallites of the bulk cuticle framework[6]. Chargaff has shown that the association of a lipoid, such as cephalin, with basic proteins, such as histone or protamine, results in the formation of relatively stable lipo-protein complexes owing to the interaction of the negative groups of the cephalin with the positive groups of the protein[7]. This complex-formation is accompanied by the expulsion of water from the hydrated protein. Since the tanning of the cuticle by *p*-benzoquinone probably involves the interaction of the quinone monomer with the $-NH_2$ groups of the protein side-chains in the lamellar cuticle fabric, it is likely that fat-solvent sensitization of the epicuticle involves the spatial displacement of lipoid, possibly of the cephalin type, which is normally attached to the basic side-chains of the protein receptors.

The physiological requirements of the cuticle as a membrane impermeable to water would be satisfied by the intercalation of labile lipoid between the protein-rich structural lamellæ of the epicuticle framework. But the association of a fat-solvent with such a simplified lamellar fabric would not induce rapid access of water-soluble or oil-soluble drugs, owing to the discontinuous nature of the lamellar receptors across the cuticle framework. However, a microscopic mosaic network of lipophilic and more hydrophilic receptor patches can be detected in the epicuticle of *Musca domestica* larvæ which have been artificially tanned with *p*-benzoquinone. The interaction of the monomer with the protein receptors is accompanied by its oxidation and polymerization *in situ*. In this way a further degree of rigidity and stability is conferred on the epicuticle framework and inner cuticle layers. The brown polymerized oxidation products of the quinone do not become uniformly distributed throughout the epicuticle, but form a mosaic of dark tanned patches enclosed within a more continuous refractile network. These discrete receptor loci are approximately 2–2·5 μ in width when seen in optical section and extend radially across the epicuticle framework to a depth of about 3 μ. When the cuticle is sensitized with a fat-solvent, the mosaic tanned network becomes more diffuse; but tanning takes place most rapidly in the discrete patches within the refractile network, showing that protective lipoid is selectively displaced from these receptor zones. After prolonged contact with fat-solvents, the labile lipoid becomes eluted from the epicuticle framework, and even the refractile regions are tanned rapidly by *p*-benzoquinone.

By combining such a mosaic receptor system with a lamellar epicuticle framework, the access of drugs becomes consistent with the physiological role of the epicuticle as a protective water-impermeable barrier, which conserves essential water in the living insect. The primary uptake of fat-solvent by the lipoid-rich mosaic receptor network increases the continuity and permeability of this phase across the epicuticle. At the same time, the immobilization and storage of fat-solvent within these loci dissolves or displaces the adjacent inter-lamellar lipoid, which accumulates in the transverse lipophilic network and increases the relative phase volume of this system. There is thus an increase in the continuity and permeability of both the lipoidal and protein-receptor components of the mosaic across the cuticle framework.

The natural hardening or tanning of insect cuticle is an enzymic process, and Dennell has provided interesting evidence to show that the localization of a phenoloxidase and polyphenol in the epicuticle of *Sarcophaga falculata* larvæ may partly explain the more rapid hardening of the outer cuticle layers[8]. According to Dennell, the polyphenol substrate of the cuticle is an oxidation product of tyrosine, which is oxidized in the blood by the enzyme tyrosinase and diffuses into the outer layers of the cuticle. The isolated cuticle of *Musca* larvæ and other insects darkens in the presence of tyrosine or catechol substrates, but hardening does not take place in the tyrosine substrate. On the other hand, a tanning process, which is analogous with the natural changes *in vivo*, occurs in catechol substrates; but the action differs from the tanning in *p*-benzoquinone substrates in that the reactive *o*-quinone is formed enzymically within the cuticle framework after access of catechol has taken place.

The natural tanning of insect cuticle, however, does not simply involve the combination of the natural polyphenol substrate with molecular oxygen in the presence of polyphenol oxidase. The addition of hydrogen peroxide to an aqueous catechol substrate greatly increases the rate of tanning of the cuticle even when the enzyme receptors have been exposed by fat-solvent sensitization. This reaction is thermolabile, and is due to the presence of a highly active polyphenol peroxidase which is secreted into the cuticle by specialized epidermal cells. Enzymic tanning may be accelerated by the presence of fat-solvents in the cuticle framework similarly to the induced tanning by *p*-benzoquinone, and this suggests that the labile protective lipoid is attached to the enzyme prosthetic groups. That the polyphenol peroxidase is associated with the protein structural components of the epicuticle mosaic is shown by the coincidence in the mosaic pattern which develops in

p-benzoquinone and in catechol substrates, but this pattern is still further intensified in the presence of hydrogen peroxide. The natural polyphenol substrate is secreted by epidermal cells into the epicuticle by means of a network of ducts which open by discrete pores on the surface of the epicuticle. The selective concentration of polyphenol in these zones produces local darkening of the cuticle in ammoniacal silver nitrate solution. The cuticle peroxidase is similar in many respects to the peroxidase in horseradish roots[9]. Catechol is rapidly oxidized by an aqueous horseradish root extract in the presence of hydrogen peroxide. The natural hardening of insect cuticle can be accelerated by abrading the outer cuticle surface and treating the abraded areas with a concentrated aqueous horseradish extract.

The cuticle peroxidase appears to play an important part in the determination of macroscopic cuticle pattern. In *Musca* larvæ and in related blowfly larvæ, the whole cuticle becomes uniformly tanned after sensitization with a fat-solvent and immersion in an aqueous substrate containing catechol and hydrogen peroxide. This is analogous to the formation of the puparium *in vivo*; but in other insects, such as *Tenebrio molitor* larvæ, a segmental cuticle pattern may be developed in a similar manner to the appearance of an image on a photographic plate by this treatment.

These examples of cuticle sensitization have been selected to show how the association of a simple fat-solvent with the cuticle receptors may initiate a complex chain of interdependent biological changes. The physical nature of the primary stimulus is shown by the fact that cuticle sensitization may be brought about by rubbing the cuticle with adsorbent powders, such as silica, charcoal, or alumina. These powders, which also act as 'inert' insecticidal dusts, not only increase the permeability of cuticle by local 'abrasion' of superficial epicuticular lipoid, as Wigglesworth has shown[10], but also induce a more uniform displacement of internal protective lipoid by adsorbing superficial lipoid from the outer layers which communicate with the internal mosaic receptor network[3]. The coincidence between the segmental tanned cuticle patterns which develop when *Tenebrio* larvæ are sensitized by fat-solvents and by the action of adsorbent powders indicates that both treatments expose the more internal peroxidase receptors to access by catechol.

In these systems there is a competition between the protective lipoid and the substrate catechol for the cuticle peroxidase receptors. But a still more complex competition is shown between two enzymes in the cuticle framework for the same component in the substrate. Peroxidase activity is inhibited by the enzyme catalase, which decomposes hydrogen peroxide into water and molecular oxygen, and so prevents the accumulation of toxic concentrations of hydrogen peroxide in the tissues. The outer epicuticle is permeable to peroxidase, but not to catalase, and the progressive hardening of the cuticle from the outside inwards which takes place *in vivo* and in catechol substrates containing hydrogen peroxide is due to the gradient of peroxidase inhibition produced by the selective localization of catalase within the cuticle framework. Similarly, selective access of catalase to the thinner intersegmental regions of the cuticle in *Tenebrio* larvæ inhibits peroxidase activity, and so the flexibility of the cuticle in these regions is maintained during the hardening of the cuticle. Here is a very interesting example of how physiological function in a protective membrane may be influenced by the selective competition of enzymes within the membrane fabric. This selective segmental tanning is not shown in *p*-benzoquinone substrates. In these systems, tanning of the cuticle depends on the general availability of protein receptors within the membrane, and tanning takes place at the intersegmental membranes.

If, by analogy with the cuticle receptor system, we assume that the toxicity of insecticides at the internal tissue receptors depends on the disturbance of the dynamic physiological balance in oxidative tissue metabolism, it becomes possible to obtain some insight into the way in which insecticides and simpler drugs of different molecular structure exert similar pharmacological actions. For example, the cuticle and tissue phenoloxidases are relatively diffusible*, and the relation between tissue peroxidase activity and the drug concentration of the hæmolymph may be studied by removing some of the cuticle from the body wall of mature *Musca domestica* larvæ and immersing the insects in standard volumes of phosphate buffer (*p*H 7·4) containing fixed concentrations of catechol (0·5 per cent) and hydrogen peroxide (5 per cent of 10 vol. solution), and variable concentrations of a simple narcotic, such as ethyl alcohol. The rate of enzymic oxidation of the catechol may be measured by the reddening of the tissues and substrate. Typical results show that with increase in the alcohol concentration of the substrate (0–6 per cent) there is a progressive decrease in peroxidase activity accompanied by the inception of narcosis in the insect. With further increase in alcohol concentration (6–25 per cent) there is no marked change in peroxidase activity; within this range drug tolerance is shown by the persistence of narcosis. This reduction in peroxidase activity cannot be due to direct combination of the alcohol with the enzyme, for with higher concentrations of alcohol (25–60 per cent), peroxidase activity rises to a maximum value higher than that in the control system in which alcohol is absent. With still further increase in alcohol concentration, peroxidase activity decreases owing to tissue denaturation. These selective changes in peroxidase activity are not shown by aqueous extracts of tissue where the enzyme is no longer associated with the structural tissue organization.

From this unusual relationship between the drug concentration in the substrate and tissue peroxidase activity, it may be inferred that the competition between a drug and a specific substrate for an enzyme does not necessarily take place according to the mass action law which generally holds in liquid non-structural systems containing isolated enzyme preparations. The selective environmental influence of a tissue component sensitive to a narcotic is shown by the parallelism between the changes in catechol peroxidase, catechol oxidase, and tyrosinase activity which takes place in the appropriate systems with change in the concentration of alcohol in the substrate†. Moreover, the rate of change of phenoloxidase activity with concentration of drug varies with different insects. For example, hæmolymph concentrations of ethyl alcohol, which decrease tissue

* This diffusion of enzymes, which are of high molecular weight, is brought about mainly by convection transport in the hæmolymph and by the movements of the living insect.

† The increase in catechol oxidase activity in the presence of lethal alcohol substrate concentrations may also be demonstrated using manometric methods, which show the correlation between the reddening of the substrate and the oxygen uptake. Similarly, colour formation and oxygen uptake are decreased by inhibitors such as hexyl resorcinol.

phenoloxidase activity in *Musca* larvæ and induce narcosis, may increase phenoloxidase activity in *Tenebrio* larvæ. Within critical ranges this increase is lethal and results in the darkening of the blood owing to an increase in tyrosinase activity. Here the substrate is tyrosine, which is a product of tissue metabolism. The intermediary stages in the tyrosinase-tyrosine reaction have been elucidated by the classical work of Raper[11]. It is clear that, in addition to a factor of cuticle permeability, the relative susceptibility of insects to the same insecticide will depend more fundamentally on an internal environmental factor associated with the stability of the tissue receptors.

The components sensitive to a narcotic must be such that the affinity of monohydric alcohols for these structural receptors is greater than the affinity of the drugs for the phenoloxidase systems. The nature of these accessory receptors is shown when a comparison is made between the narcotic actions of the lower members of the homologous series of monohydric alcohols. In *Musca* larvæ, the exponential rate of decrease in the threshold concentrations of narcotic in the substrate or drug in the hæmolymph as the series is ascended from methyl to amyl alcohol forms a Traube series characteristic of drug distribution between immiscible oil/water phases. Similar results have been described for related blowfly larvæ[3]. From this evidence it would seem that the narcotic sensitive tissue receptors are lipoidal, or more probably lipo-protein in nature. The increase in phenoloxidase activity at lethal concentrations of drug suggests that the permeability of the tissue receptors to drug and essential substrate molecules is increased by the displacement of protective lipoid from the protein-enzyme tissue complex. But apart from this permeability factor, depending on lipoid solubility, the lipoid receptors also influence the steric approach of the drug to the enzyme receptors, for with the capillary-active alcohols reduction in tissue phenoloxidase activity takes place only within the range of biological drug concentrations where the displacement of protective lipoid is reversible. At higher lethal drug concentrations, this selective steric factor is no longer dominant owing to the dispersion of protective lipoid from the enzyme. In a similar way, access of substrate catechol is influenced by the non-polar association of the benzene nucleus of the catechol molecule with the lipoid receptors, and by the more specific two-point polar attachment of the hydroxyl groups of the catechol with the prosthetic groups of the enzyme.

One important result which emerges from these biological complexities is that narcosis and lethality are only indirectly related to changes in aerobic phenoloxidase activity, owing to the selective environmental influence of the tissue receptors sensitive to a narcotic. But it is known that the tissue or cell dehydrogenases are also inhibited by narcotics or depressants, and in order to gain an insight into the nature of drug specificity it is necessary to study the action of these drugs on the aerobic and on the anaerobic components of respiratory systems. Dehydrogenase activity is usually studied by determining the rate of reduction of an autoxidizable dye, such as methylene blue, in the presence of tissue, substrate, and drug, under anaerobic conditions. When methylene blue is injected into the hæmolymph of insects, the dye is taken up by the tissues, and is partly or completely reduced, depending on the concentration of dye present, and on the oxidation-reduction potential of the substrate. If drugs are now applied externally to the insect cuticle, the change in the colour of the dye, which may be observed through the cuticle, gives an indication of the relative changes in dehydrogenase activity. At the same time, the darkening of the blood and tissues provides a measure of the changes in aerobic tyrosinase activity. In this way the dynamic changes in aerobic and anaerobic oxidative processes may be compared under conditions in which insecticides are usually applied to insects *in vivo*. Suitable test insects are *Tenebrio molitor* larvæ, or mature *Musca domestica* larvæ. Some significant conclusions emerge when a comparison is made between the action of simple non-polar and polar or capillary-active drugs. These may be summarized briefly as follows.

(1) Both the aerobic and anaerobic enzymic oxidative processes are influenced by the tissue receptors sensitive to a narcotic.

(2) The transition from narcosis to death induced by the action of non-polar fat-solvents such as hexane, *cyclo*hexane, benzene, or chloroform is accompanied by an increase in tissue phenoloxidase activity and tissue dehydrogenase activity, suggesting a sensitization of the structural lipo-protein tissue receptors which is analogous to that induced in the mosaic lipo-protein receptor organization of the insect cuticle.

(3) Increase in the hæmolymph concentration of primary monohydric alcohols produces a similar sensitization of the tissues as non-polar fat-solvents, but with the lower members (methyl → propyl alcohol) the increase in tissue tyrosinase at lethal concentrations in the hæmolymph is accompanied by an inhibition in dehydrogenase activity, suggesting a more specific susceptibility of these systems to the alcohol hydroxyl group. The competition between the lipoid tissue receptors and the dehydrogenase receptors for the drugs is shown by the fact that, as the drug series is ascended from propyl to butyl alcohol, the inhibition of dehydrogenase activity falls off sharply, and with higher homologues the fat-solvent properties of the molecules are dominant factors in activity.

(4) With the related homologous series of monocarboxylic acids the relatively strong polar interaction of the carboxyl groups with the protein-enzyme receptor complex is dominant, and both phenoloxidase and dehydrogenase activity are inhibited by low concentrations of drug in the hæmolymph.

(5) The narcotic and lethal actions of non-polar fat-solvents and inert fat-soluble drugs, such as primary alcohols, are probably associated mainly with changes in aerobic oxidative enzyme activity. The phenoloxidase systems in *Tenebrio* larvæ are much more sensitive to drug-dispersant action than in *Musca* larvæ, where the insects are much more resistant to the narcotic action of fat-solvents in general. On the other hand, the tissue dehydrogenase systems show similar degrees of susceptibility in both species of insect.

These principles appear to be of general application in wider fields of pharmacology and suggest that the discrepancies which have hitherto existed between the simple principles of Overton-Meyer, Traube and the somewhat static specific group concepts of Ehrlich are fundamentally biological. The changes in enzyme activity, which are dependent on changes in the selective environmental influence of the lipo-protein tissue receptors, suggest the interesting possibility that the cytochrome system, which is

probably the most important component of the respiratory system in insects and other organisms[12], is similarly influenced, and it is hoped to investigate this aspect by the use of spectroscopic techniques.

When we come to examine more complex insecticidal systems, it is clear that similarity in biological response may merely indicate a coincidence in the dynamic chain of metabolic changes initiated at different links in the chain. For example, pyrethrins I and II are complex unsaturated ketonic esters which differ completely in molecular structure from the relatively simple inert fat-soluble D.D.T.[1]. Yet similarity in insecticidal action is shown by a dispersant action on the cuticle and internal tissue lipoids, and the lethal stages of poisoning reveal an increase in the phenoloxidase activity of tissue and hæmolymph. The minute nature of the lethal dosages is consistent with an adsorption process on the tissue receptors; but it is unlikely that narcosis or death is directly related to primary insecticide-tissue combination. A contributory factor may be the accumulation of reactive *o*-quinones which would block essential substrate access to the whole complex of enzyme systems normally associated with the tissue components. This narcotic stage would be followed by death when the further dispersant action of the insecticides resulted in the accumulation of lethal concentrations of toxic quinonoid metabolites in the tissues. Richter[13] has shown the general similarity between the catechol oxidazes in plants, fungi and insects, and has found that oxygen uptake is greatly reduced by the *o*-quinone reaction products, which combine with the available catechol oxidase. However, these more specific factors in insecticidal action are beyond the scope of the present article and will be considered elsewhere.

This account is based on an investigation into the fundamental mode of action of insecticides and drugs which is being carried out by me at the Department of Colloid Science, Cambridge. I wish to express my deep indebtedness to Prof. E. K. Rideal and to Dr. J. H. Schulman for much helpful advice and stimulating discussion, especially on the physico-chemical aspects of the work.

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OBITUARIES

Miss E. R. Saunders

When Edith Rebecca Saunders died on June 6 at the age of eighty as the result of a bicycling accident in Cambridge, there passed one to whom many scientific women owe a great debt for her labours on their behalf in the early days of the higher education of women. Others have written of the value of her botanical research work, but not the least valuable part of her services was the organization and training of many generations of science students at Girton and Newnham Colleges.

In the early days of the higher education of women at Cambridge, the University lectures were not open to women and the teaching of science was left entirely to the women's colleges to provide as best they might. Friends of the women helped when they could, but there was no help from the University as such. Very soon after Miss Saunders had taken her Tripos she was appointed demonstrator in biology at Newnham College and taught the students of both Girton and Newnham Colleges; later she became a lecturer, and together with the late Mrs. Bidder (Marion Greenwood) helped to organize all the practical work in biology and botany given in what came to be known as the Balfour Laboratory. This building, a former Nonconformist chapel given to Newnham College by the generosity of Mrs. Sidgwick and Miss Balfour in memory of their brother Francis Maitland Balfour, the zoologist, was converted into the Balfour Laboratory under the direction of Miss Greenwood and Miss Saunders, and here Miss Saunders taught for many years, becoming its director after Miss Greenwood's marriage to Dr. Bidder.

She always set before her pupils a high standard, and much excellent work was carried out by them there. Even after many University professors and lecturers opened their lectures to women, all the practical work for Part I of the Tripos was still organized and carried out by her, until the new University Laboratories were built and accommodation provided in them for the women students.

There must be many women employed in scientific work in universities, colleges, schools and other places all over the world who know that they owe their present position and success largely to the stimulus of Miss Saunders' teaching and the high quality of the work on which she insisted.

G. L. Elles.
Ethel Shakespear.

The main writings of Miss E. R. Saunders relate to floral morphology. The most important of them were issued between 1923 and 1936 in the *Annals of Botany*, the *New Phytologist*, the *Journal and the Proceedings of the Linnean Society*, the *Journal of Botany* and the *Journal of Genetics*, and in two volumes published by Messrs. Heffer and Sons. The earliest of them furnished a factual basis for a new and interesting outlook on gynœcial morphology; the later documents elaborated a theory of carpel polymorphism and brought to focus important problems of systematic and evolutionary interest which are still unsolved.

The first of these writings appeared at a time when some rendering of the classical conception of a monomorphic carpellary 'leaf' gave contentment to many inquirers. They looked on such an organ as the basic unit of gynœcial construction in all groups of flowering plants and thought of it as possessed of a median style and a distal stigma. Whatever was their mode of approach to floral matters, their common purpose was to settle long-standing differences of opinion regarding the 'basic numbers', arrangements and forms of such 'leaves' for all types of 'syncarpous' gynœcia and to furnish for each alliance a 'fundamental ground-plan of floral construction'.

Few indeed were prepared to describe precisely the 'foliar' prototypes of which they spoke; but many

acted on the view that such common 'free' carpels as follicles and achenes exemplified their units and demonstrated some of the ways in which still older organs had been transformed, reduced in numbers, aborted or suppressed, and gradually rearranged on some uniform specific plan. Despite their union in pistils, they still showed, per species, a single carpel-form. Nevertheless, although there was constant reference to facts of development and histology and to all manner of final forms of pistil, opinion on gynœcial construction had come no nearer to harmony than it had been from the days of Braun and Eichler to those of Kerner and Klein.

The bearing of Miss Saunders' views may be made plain through a few points of past interest. Thus, while some believed that facts of development were of great value in the interpretation of all organs, others considered that adult form and structure gave the surest guide. There was also a mode of thought which gave prominence to vascular tissue not only as a major index to the status of an organ but also as a sign of its modification, or as a pointer to its prior development in a given position. There was a common language explaining the arrangement of vascular strands, their modes of branching, the remarkable conservatism of a vascular system, and the usefulness of 'vestigial' strands in tracing the old sites of arrested organs. Further, some believed that a leaf may be truly terminal since, as they said, a legume is a unit carpellary leaf and is fully distal. Others rejected this view and regarded a legume as the sole and displaced survival of a lateral group of 'leaves'. They read all 'syncarpous' gynœcia according to their notions of numbers and arrangements of lateral leaves, of those which had been suppressed, and of those which were now displaced.

Miss Saunders entered this field convinced that there could be no agreement on a 'fundamental ground-plan' for any pistillate family so long as the concept of a monomorphic carpel was the starting point in phyletic discussion. She pointed, in particular, to the unsettled controversies over pistil construction in the Cruciferæ and other affinities, to the seemingly insoluble problem of the 'commissural' stigma, to the varying interpretations of obdiplostemony, to the wide range of ovule placentation still unexplained, and to the difficulties facing all monomorphists when they turned to families with 'supernumerary' styles. For these and all related matters she claimed the need of a new approach.

Her first proposal was as startling as it was simple, in that it visualized carpel dimorphism as shown to-day by many flowering groups. The heart of her view was that even a single pistil comprises united leaves; some with the form and the function of ovule-bearing organs, others of distinctive form and the function of which is stigmatic. Through this she sought early to rationalize cruciferous and other gynœcia and to explain the presence of commissural stigmas. As did others who opposed her plan for an extension of a 'leafy' view of carpels, she relied largely on the form and vasculation of mature organs. She came to identify and arrange her united carpel forms according to her estimate of branched or unbranched vascular strands, the positions of ovules upon ovarial walls, the arrangement of stigmas, and the older conception of the cyclic construction of a flower. It was inevitable that she should reject the conception of a terminal leaf once she had decided to interpret a distal legume as a union-product of distinctive carpel forms. Also it was natural that, with strands as a major instrument in the identification of unit organs, she extended her dimorphic view into a doctrine of carpel polymorphism. One cannot attempt to outline the many directions in which she sought later to apply her theory and to settle once and for all the fundamental ground-plans of floral construction on which she had set her heart. But her final volumes are in themselves a glowing testimony to the breadth of her inquiries, to her courage, and to the great array of facts which she disclosed.

It may be long before there is common agreement as to the chief objective of floral study and the valuation of the evidence on which Miss Saunders relied. But it may truly be said that few of her contemporaries in formal morphology stirred imagination more deeply than she, or did so much to stimulate inquiry. J. McL. Thompson.

Mr. H. E. Potts

The very narrow but nevertheless important field of patent law and practice has lost a great mind by the death of Mr. H. E. Potts on July 4. He was an earnest and original contributor to the literature of patent law. Early in his career as a chartered patent agent, he was struck by the fact that, in the drafting of patent specifications and claims, a patent agent had to call upon powers of analysis and then subsequent synthesis, and that this logical process should have some analogy in mathematics. His first contribution on "An Application of Mathematics to Law" was indeed to *Nature* of April 24, 1913 (p. 187), and this has been followed over the years by a development of the idea there lightly touched upon.

Although possibly never hitherto positively appreciated, it is nevertheless a fact that a patent granted upon an invention when tested by the High Courts of Great Britain is either 'wholly bad' or 'wholly good'. It is believed that Mr. Potts was the first to point out that there should be some method of assessing validity quantitatively, as well as qualitatively; and recently he put forward a number of suggestions in regard to the appreciation of monopolies of invention as granted by the Crown on a graduated basis, as distinct from the 'all good' or 'all bad', developing this proposition side by side with its mathematical exposition and following accepted theories of modern philosophy.

Of many valuable publications, perhaps Potts' best known is his book "Patents and Chemical Research", which has become a standard work in the literature on patents.

We regret to announce the following deaths:

Mr. A. D. E. Elmer, the distinguished plant collector and author of many papers on the botany of the Philippines, in July 1942.

Dr. Frank Blair Hanson, associate director for the natural sciences at the Rockefeller Foundation, formerly professor of zoology at Washington University, St. Louis, on July 21, aged fifty-nine.

Dr. Gustave M. Meyer, associate in biochemistry during 1913–41 at the Rockefeller Institute for Medical Research, known for his work on carbohydrates and tissue chemistry, on May 9, aged sixty-nine years.

The Ven. Lonsdale Ragg, founder and editor of the *Tree Lover*, and known for his drawings of trees, on July 31, aged seventy-eight.

NEWS and VIEWS

New Linacre Professor at Oxford : Prof. A. C. Hardy, F.R.S.

Prof. A. C. Hardy, whose recent appointment as Linacre professor of zoology and comparative anatomy at Oxford has been announced, is especially distinguished for his work in the sphere of oceanography. He is a leading authority on marine plankton, and throughout his researches has stressed the ecological aspect. Prof. Hardy started his career as a member of the Ministry of Agriculture and Fisheries Research Staff at Lowestoft in 1921, working on the natural history of the herring in relation to the plankton. In 1924 he joined the research staff of the *Discovery* as chief zoologist under the late Dr. Stanley Kemp. He went on the Antarctic voyage of 1925–27, and published, with the late Dr. E. R. Gunther, important results on the ecology of plankton animals in southern waters. These included studies of animal and plant interrelations (developing his hypothesis of animal exclusion), 'patchiness' of plankton, correlations of whale and plankton distribution, vertical migration and the combined effect of this with varying current systems at different depths.

In 1928 Prof. Hardy became the first professor of zoology and oceanography at the University College of Hull, where he developed on a large scale the use of his continuous plankton recorder, which he had originated while with the *Discovery*. He also demonstrated herring-plankton distribution correlations with his smaller plankton indicator, which has now become a commercial instrument. In 1942, Prof. Hardy was appointed regius professor of natural history in the University of Aberdeen. In recent years he has widened his interests to include the air, undertaking research on the aerial plankton, for which he has devised gear for catching insects in the upper air from kites and aircraft. Prof. Hardy is thus well fitted to help and enlarge the scope of the well-known ecological researches already being carried out at Oxford.

British Cotton Industry Research Association Fellowships

The Council of the British Cotton Industry Research Association has decided to make an annual award of a limited number of research fellowships with the object of training young men in research methods in pure science, and particularly those branches of prime interest to the Association. The Association conducts research into the utilization of cotton, rayon, silk and synthetic fibres, and examples of scientific fields of present interest to the Association are: carbohydrate and protein chemistry; fundamental studies of high polymers; photochemistry; fundamental physical studies relating to properties of matter or electronics; theory of instrumentation; mathematics; studies on the colloidal state. The fellowships will be open to graduates of British nationality and will be tenable at any British university. Their value will depend on circumstances, but will not in any case be less than £200 per annum. The Association will be guided in its choice of the location of fellows chiefly by the type of research conducted by the professor under whose direction the candidate elects to work. Application for election to a fellowship should therefore be made through the professor and should be accompanied by a statement of the problem to be studied. It will be normal for the Association to wish to interview candidates, but the recommendation of the professor will be an essential and will carry great weight in the selection. Applications should be forwarded to the Director, British Cotton Industry Research Association, Shirley Institute, Didsbury, Manchester, not later than two months before the commencement of the work.

The object of the fellowships being to train young graduates in fundamental research methods, they will not be awarded for specific problems in connexion with industry. Further, the results of researches carried out with the assistance of a fellowship will be published from time to time in the scientific journals at the discretion of the professor directing the work, and if deemed by him worthy of such action. The only condition attaching to publication will be that suitable acknowledgment shall be made by authors of the receipt of a fellowship. Without in any way implying direction of or interference with the research, the Association would wish to feel free through its director of research to discuss progress with fellowship holders from time to time, and fellows would be given opportunities to visit the Association's laboratories, and thus become acquainted with the problems of the textile industries. Save in exceptional circumstances, the Association will not make more than two consecutive annual grants to the same person.

College of Aeronautics

The following have been appointed to be the Board of Governors of the College of Aeronautics for postgraduate instruction in aeronautical science and engineering, which, as announced in the House of Commons in October last, is being created in accordance with the recommendations of the Committee presided over by Sir Roy Fedden, the report of which was issued last year: Air Chief Marshal Sir Edgar Ludlow-Hewitt (*chairman*), Dr. W. Abbott, Mr. H. Burroughes, Sir Roy Fedden, Mr. J. Ferguson, Sir Harold Hartley, Sir William Hildred, Sir Melvill Jones, Dr. E. B. Moullin, Mr. J. D. North, Sir Frederick Handley Page, Mr. E. F. Relf, Dr. H. Roxbee-Cox, The Lord Selkirk, Air Marshal Sir Ralph Sorley, Sir William Stanier, Rear-Admiral T. H. Troubridge and Mr. W. E. F. Ward. Invitations are being extended to the Governments of the Dominions and India which may wish to be associated with the College to appoint representatives on the Board of Governors. Preliminary steps are now being taken with the view of opening the College some time in the course of next year in temporary accommodation to be provided at Cranfield, pending the provision later of permanent premises.

Sensory Devices for the Blind Committee

The Council of St. Dunstan's has set up a committee to be known as the Sensory Devices for the Blind Committee, and the following have agreed to serve: Prof. E. D. Adrian, professor of physiology, University of Cambridge (*chairman*); Dr. Clifford Paterson, director of the Research Laboratories, General Electric Co., Ltd., Wembley; Mr. Thomas Smith, superintendent of the Light Department, National Physical Laboratory; Flight-Lieut. E. Barton; Dr. B. H. C. Matthews, head of the R.A.F. Physiology Laboratory, Royal Aircraft Establishment, Farnborough; Mr. H. L. Kirke, head of the Engineering Research Department, B.B.C.; and Sir Ian Fraser. The Committee has had two preliminary

[None of the vacancies in these columns relates to a Man between the ages of 18 and 50 inclusive or a Woman between the ages of 18 and 40 inclusive, unless he or she is excepted from the provisions of the Control of Engagement Order, 1945, or the vacancy is for employment excepted from the provisions of that Order.]

MURDOCH TRUST

For the BENEFIT of INDIGENT BACHELORS and WIDOWERS of good character, over 55 years of age, who have done "something" in the way of promoting or helping some branch of Science.

Donations or Pensions may be granted to persons who comply with these conditions.

For particulars apply to MESSRS. SHEPHERD & WEDDERBURN, W.S., 16 Charlotte Square, Edinburgh, 2.

UNIVERSITY OF ABERDEEN

STRATHCONA-FORDYCE CHAIR OF AGRICULTURE

The Strathcona-Fordyce Chair of Agriculture which is under the patronage of the Curators of the Chair is vacant through the resignation of Professor Sir John Orr, D.S.O., M.C., LL.D., F.R.S. Persons who desire to be considered for the post are requested to lodge their names with the Secretary of the University by August 31, 1945.

Conditions of appointment may be obtained from the undersigned.

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

THE UNIVERSITY OF SHEFFIELD

Applications are invited for the post of LECTURER in the DEPARTMENT of METALLURGY. A candidate should be specially interested in PHYSICAL METALLURGY and must possess a good HONOURS degree in Physics and relevant research experience.

Salary £570 per annum, with war-time marriage and children allowance and Superannuation provision under the Federated Superannuation Scheme for Universities.

Applications (six copies) with the names and addresses of three referees and, if possible, copies of not more than three testimonials should reach the undersigned (from whom further particulars may be obtained) by September 15, 1945.

A. W. CHAPMAN,
Registrar.

CIVIL SERVICE COMMISSION DUBLIN

POSITIONS VACANT: ASSISTANT INSPECTORS OF FISHERIES (2) (MALE) IN THE DEPARTMENT OF AGRICULTURE.

Application forms for, and particulars of, the above-named posts may be obtained from the Secretary, Civil Service Commission, 45 Upper O'Connell Street, Dublin. *Salary Scale;* £150–15–£350 a year, plus bonus. At present the minimum bonus on £150 is £153 14s. 4d. A higher initial salary may in certain circumstances be allowed. *Age Limits;* 25–40 years on August 1, 1945, except in the case of persons with certain specified service in the Defence Forces or such Auxiliary Defence Services as may be determined. Each candidate must hold a recognized University degree in Science, including the subjects Botany and Zoology or possess an equivalent qualification.

Latest time for accepting completed application forms: 5.15 p.m. on September 14, 1945.

THE UNIVERSITY OF LIVERPOOL

Applications are invited for the post of a full-time Demonstrator in Physiology for Session 1945–46, at a salary of £350 per annum. Further particulars may be obtained from the Registrar.

The University will consider applications from candidates who are still serving in the Forces or are engaged upon other national service, and leave of absence can be given to a successful candidate until some time after the date of release from the Forces or other National Service.

Applications, giving details of qualifications and career, accompanied by testimonials and/or references, should be forwarded to the undersigned not later than August 31, 1945.

STANLEY DUMBELL,
Registrar.

UNIVERSITY OF EDINBURGH

The University invite applications for a Grade B Lecturer in Physiology. The salary will be at the rate of £550, rising to £650 per annum, and the Lecturer will be required to join the Federated Superannuation Scheme. Applications should reach the undersigned by November 10, 1945.

W. A. FLEMING,
Secretary to the University.

NATAL UNIVERSITY COLLEGE PIETERMARITZBURG

Applications are invited for the post of LECTURER IN GEOGRAPHY. Salary scale: Men £450 × £25—£600; Women £350 × £25—£500 plus current cost of living allowance. Appointment in first place will be for the probationary period of one year. Allowance for travelling expenses.

Further particulars may be obtained from the Secretary, Universities Bureau of the British Empire, c/o University College, Gower Street, London, W.C.1. Closing date for receipt of applications, September 15, 1945.

NATAL UNIVERSITY COLLEGE PIETERMARITZBURG

Applications are invited for the post of LECTURER IN ZOOLOGY. Salary scale: Men £450 × £25—£600. Women £350 × £25—£500 plus current cost of living allowance. Appointment in first place will be for the probationary period of one year. Allowance for travelling expenses.

Further particulars may be obtained from the Secretary, Universities Bureau of the British Empire, c/o University College, Gower Street, London, W.C.1. Closing date for receipt of applications September 15, 1945.

ESSEX EDUCATION COMMITTEE

ESSEX INSTITUTE OF AGRICULTURE

Writtle, Nr. Chelmsford

Applications are invited for the post of Assistant Lecturer in Agriculture. Applicants should possess a Degree in Agriculture. Salary in accordance with the Burnham Scale for Assistants in Technical Colleges. The post in the first instance will be temporary.

Forms of application may be obtained on receipt of a stamped addressed envelope from the undersigned, and should be returned by August 31, 1945.

B. E. LAWRENCE,
County Offices, Chief Education Officer.
Chelmsford.

ESSEX EDUCATION COMMITTEE

ESSEX INSTITUTE OF AGRICULTURE

Writtle, Nr. Chelmsford

Applications are invited for the post of Lecturer in Agricultural Economics. Applicants should possess a University Degree. The minimum commencing salary will probably be £500 per annum. The post in the first instance will be temporary.

Forms of application may be obtained on receipt of a stamped addressed envelope from the undersigned, and should be returned by August 31, 1945.

B. E. LAWRENCE,
County Offices, Chief Education Officer.
Chelmsford.

IMPERIAL BUREAU OF ANIMAL BREEDING AND GENETICS, EDINBURGH

Assistant required. Applications are invited from University Graduates with knowledge of Russian. German and other European languages. Experience of abstracting scientific literature an advantage; training or experience in biological science desirable. Salary scale: £300–15–£390, with War Bonus. Applications to be sent by August 25 to the Deputy Director, Imperial Bureau of Animal Breeding and Genetics, King's Buildings, West Mains Road, Edinburgh 9.

NORTHAMPTON POLYTECHNIC

ST. JOHN STREET, LONDON, E.C.1

Applications are invited for the post of full-time LECTURER in the Applied Chemistry Department.

Salary in accordance with the London Burnham Scale for Teachers in Technical Institutions.

Conditions of appointment and form of application on request to the Secretary.

S. C. LAWS, O.B.E., M.A., M.Sc.,
Principal.

THE UNIVERSITY OF MANCHESTER

Applications are invited for the post of LECTURER IN BOTANY. Stipend £400 per annum, rising according to scale. Duties to commence September 29, 1945, or a later date to be arranged. All applications must be sent not later than August 25 to the Registrar, The University, Manchester, 13, from whom further particulars may be obtained.

UNIVERSITY COLLEGE OF SWANSEA

The Council invites applications for the post of Temporary Assistant Lecturer in Geography for one year from October 1, 1945. Salary £350. Further particulars may be obtained from the Registrar, University College, Singleton Park, Swansea, by whom applications must be received on or before August 28, 1945.

UNIVERSITY OF LEEDS

Applications are invited for appointment as Research Assistant and Demonstrator in Zoology. Salary £250.—Further particulars may be obtained from the Acting Registrar, to whom applications should be sent not later than August 25.

University College, Cardiff, invites applications for these posts in the Advisory and Research Department in Agriculture (a) Senior Assistant Apiculturist for research, lecturing and advisory work on various aspects of beekeeping, (b) Senior Assistant Biologist for full-time research on pollination of clover and other farm crops, (c) Senior Assistant Entomologist for supervising experiments and undertaking advisory work, (d) 3 Junior Assistant Entomologists for laboratory and field investigations on farm and garden pests, (e) Assistant Mycologist to the Adviser in Agricultural Botany. The salaries will be on the range £300 to £375 for the Senior posts and £240 to £275 for the other appointments, with war bonus in both ranges at £60 per annum. Six copies of applications, stating age, qualifications and experience, together with six copies of recent testimonials, must be submitted by August 22 to Registrar, University College, Cathays Park, Cardiff.

Instrument Manager for growing section of a Works production. Post calls for young man of drive and initiative with eye to future rather than immediate position. Technical qualifications in Electrical Engineering or Physics necessary besides good all-round instrument production experience in order to co-operate with Research Department in development of instruments largely connected with high vacuum industrial and laboratory equipment. Box No. 383, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Chambers's Encyclopaedia require half- or full-time services as Editorial Assistant for not more than two years, of University Graduate with a higher degree in Zoology. The work includes writing new material, revising old material and working under the instructions of the Editor in Charge of the Zoological Section. Salary £350–£500 a year, according to the time given. Apply stating qualifications to Box 386, T. G. Scott and Son, Ltd., 9, Arundel Street, London, W.C.2.

Physicist required by small progressive Company near to London producing special electrical equipment. A good knowledge is necessary of electronics, particularly trigger circuits, and high vacuum equipment.

The successful candidate will be expected to work on his own initiative in conducting experiments with the Company's products, seeking improvements and new applications.

Salary according to age, experience and qualifications, particulars of which to Box 384, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Well-known London Company (Sched-uled under Essential Work Order) requires lady possessing Science degree with experience in abstracting technical literature or presentation of statistics preferably in chemical or allied industry. Knowledge of technical German essential. Applicant should also have knowledge of Shorthand and Typewriting.—Write giving full particulars of qualifications, experience, age and salary required to Box 388, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Genatosan invite applications from men qualified to prepare medical literature and copy. Applicant should have some knowledge of modern pharmacology and therapeutics and have the ability to write clearly and convincingly. A qualification in chemistry and/or pharmacy an advantage, but not essential. Remuneration will be according to qualifications and experience. Apply—giving full particulars of age, qualifications, experience, salary required and date available to take up duties if appointed—to the Secretary, Genatosan, Ltd., Loughborough, Leics.

Biochemist required for Chemothera-peutic research in well-known firm of manufacturing chemists. Some research experience preferable. Salary according to qualifications and experience.—Apply Box 387, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Applications are invited from women for a post of indexer and abstractor of technical publications in the Mineral Resources Department of the Imperial Institute. A knowledge of foreign languages is essential and familiarity with scientific literature an advantage. Salary £248 p.a. including war bonus which at present amounts to £48 p.a. Further particulars on application to the Establishment Officer, Imperial Institute, South Kensington, London, S.W.7.

Applications are invited for two posts of Demonstrators, one in the Division of Chemistry and one in the Division of Histology at the Royal Veterinary College, Camden Town, N.W.1, on a salary of £250 a year together with war bonus which amounts at present to £1 3s. 0d. a week (men) or 18s. a week (women). The appointments will be on probation for one year in the first instance. Applications, giving age and past record, should be sent to the Bursar, Royal Veterinary College (temporary address), The University, Reading, not later than September 1.

Physicist (male) required by firm in Lancashire. Age about 30. Qualifications desired: University training and research experience on metals. Knowledge of deformation of materials under stress, and experience on X-ray work an advantage. Knowledge of German useful. Salary from £450 to £500 according to ability.

Write, quoting A.781.XA, to Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 670, York House, Kingsway, London, W.C.2, for application form which must be returned completed by August 24, 1945.

Laboratory Steward required in September for the Chemical Laboratory of the Royal Holloway College (University of London). Wages according to age and experience. Application should be made in writing to the Secretary to the Governors, Royal Holloway College, Englefield Green, Surrey.

Young man, interested in Geology, seeks interesting work in any useful branch of the subject.—Box P.127, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Graduates in Chemistry or Physics required for the abstracting of scientific and technical literature. Knowledge of French and German essential. Applications to the Director, British Cotton Industry Research Association, Manchester, 20.

B.Sc. (Agric.), 21, exempt, desires post as assistant master in Agricultural or Rural Biology department. Eighteen months' farm experience, sports, O.C.T.—Box P.129, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Physicist, 20 years' experience Vacuum Technique, many original publications and patents, seeks responsible position England or abroad. Good references. Write Box P.130 T. G. Scott & Son, Ltd., 9 Arundel Street, London W.C.2.

Which Scientist is willing to translate Latin scientific text (mineralogy), about 10 typewritten pages?—Enquiries Box 390, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

University College, London, has a vacancy for a Radiographer in the Department of Anatomy. Salary £450 to £500 according to qualifications and experience. Apply to the Secretary, University College, London, Gower Street, W.C.1.

Experienced Glassblower required to take charge of Department. Knowledge of mechanized methods and high vacuum technique an advantage. Box 392, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Man experienced in high vacuum technique required to take charge of Department manufacturing Mercury Switches. Knowledge of Glasswork an advantage. Box 393, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

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Collection of British Lepidoptera for sale, including several rare specimens, in two mahogany cabinets, 12 drawers and 10 respectively.—Further particulars from Mr. E. F. Johns, Cardew, Alresford, Hants.

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meetings and on its advice St. Dunstan's has decided to set up a Research Unit and to seek the full-time services of a research physicist and a biologist. Through the generosity of an anonymous benefactor, a substantial sum of money has been made available for the work of the Committee over a period of five years. The Committee will not only investigate guiding devices for the blind but also methods whereby the printed word in an ordinary book can 'read aloud' to the blind; the improvement of recorded talking books; braille machines, and other apparatus. The research work will include the better use of the little glimmer of sight which remains with many people who are technically blind, and the substitution of the sense of sight by the other senses.

Localization in the Visual Cortex

Dr. Gordon Holmes, in his Ferrier Lecture before the Royal Society on "The Organisation of the Visual Cortex in Man" (*Proc. Roy. Soc.*, B, **132**, 348; 1945), dealt chiefly with the question of localization within the visual area of the cerebral cortex. As he himself has shown, by study of the visual-field defects resulting from gunshot wounds of the cortex, there is apparently a very sharp point-to-point representation of the retina in the cortex. The conception of definite fixed anatomical connexions between each point of the retina and the corresponding point in the cortex has been supported by recent histological studies of the actual nerve fibre connexions, particularly by Le Gros Clark. Such a rigid fixed relationship between retina and cortex would appear, however, to stand in marked contrast to the situation in other parts of the cortex, notably the motor area, where localization is by no means sharp and undergoes considerable physiological variations. But more recent clinical studies have shown that there must be a good deal of plasticity in the functional organization of the visual cortex. For example, patients suffering from hemianopia compensate for the loss of half the visual field by developing a new fixation point ('false macula') in the centre of the surviving field of vision; a similar adaptation occurs in a squinting eye. In such cases there must be a complete functional reorganization in the cortex, though the fibre connexions, of course, cannot change. The conclusion is that, although there is an accurate point-to-point representation of the retina in the cortex, the functional organization of the visual cortex is not thereby rigidly fixed; on the contrary, it exhibits considerable plasticity.

Recent Earthquakes

During April and the early part of May 1945, the United States Coast and Geodetic Survey, in co-operation with Science Service and the Jesuit Seismological Association, determined the provisional epicentres of five earthquakes. The first two occurred on April 15, the first at 2h. 35·2m. G.M.T. and the second at 19h. 50·6m. G.M.T. The former had an epicentre at lat. 56° N., long. 164° E., which is east of Kamchatka, and the latter an epicentre at lat. 22·5° N., long. 108·0° W., which is off Mazatlan, Mexico. The third earthquake was on April 19 at 13h. 03·5m. G.M.T. from an epicentre near lat. 40° S., long. 179° E., which is east of New Zealand. The earthquake of April 21 at 17h. 14·5m. G.M.T., according to the calculations based on reports from twelve earthquake observatories (instrumental), had its epicentre at lat. 19·3° N., long. 100·6° W. Its depth of focus was below normal, probably 50–100 km. below the surface of the earth. The earthquake was felt in Mexico. The fifth earthquake was on May 19 at 7h. 55·8m. G.M.T. The provisional epicentre, based on instrumental reports from eight observatories, has been estimated at lat. 16·0° N., long. 98·4° W., which is west of Mexico.

Mr. E. W. Pollard, at his observatory at Binstead, Isle of Wight, registered five earthquakes during April, the first on April 15 being the greatest. May is reported as being a very quiet month, only two earthquakes being recorded, on May 9 and 19. The former was small and the latter medium strength.

Localization of Faults in Low-Voltage Cables

Practical limitations of well-known fault-locating tests are considered, and some new tests capable of high accuracy are described, in a paper read by J. H. Savage recently before the Institution of Electrical Engineers in London. The new tests include a D.C. valve-voltmeter circuit for core-to-sheath insulation faults, audio-frequency search methods for open circuits and radio-frequency tests for conductor defects. Mention is also made of fault localization based on wave-reflexion effects. The paper deals mainly with factory technique for rubber- and plastic-insulated cables; but some of the methods can be applied to other types and to field work. As faults on cables carrying current are accompanied by local changes of electric and magnetic fields, and circuit unbalance and wave reflexions can be produced, future developments are likely to be in the direction of electronic devices, because these are eminently suitable for detecting and recording such effects.

Chinese Visitors to Britain

Eight Chinese visitors of widely varying professions are visiting Britain as guests of the British Council: Dr. Wang Ging-Hsi, director of the Institute of Psychology of the Academia Sinica, a well-known Chinese physiologist; Dr. Sah Pen-Tung, president of the National University of Amoy, Fukien, who is a physicist especially interested in radio-engineering; Dr. Yang Chen-sheng, professor of Chinese literature, and acting dean of the College of Arts of the National University of Peking; Prof. Tung Li Yuan, librarian of the National Library, Peking; Colonel (Mrs.) Chow Mei-You, head of the Nursing School in the Army Medical School; Miss Gao Ren-Ying, acting national general secretary of the Chinese Y.W.C.A., who is studying social conditions in Britain; Miss Priscilla Huang and Miss Chi-yi Chen, both of whom are interested in children's and women's welfare and all services of rehabilitation of war casualties.

Canadian Awards for Postgraduate Training

The National Research Council of Canada is providing opportunities for postgraduate training in science for men and women whose studies have been delayed or interrupted by war service, either military or civilian. Three classes of award are available for the academic year 1945–46 as follows: bursaries (450 dollars) for students who have graduated with high distinction in scientific subjects; studentships (750 dollars) for students who have had experience in research work in science for at least one year following graduation; fellowships (900 dollars) for students who have given distinct evidence of capacity to conduct independent research in science. One group of applications is under consideration and

awards will be announced before October 1, 1945. Additional applications received by November 15, 1945, will be considered and awards announced by December 31, 1945. Detailed information with respect to these awards and a copy of the required application form may be secured upon written application to the Secretary-Treasurer, National Research Council, Ottawa.

University of Durham : Appointments

Dr. A. C. Offord has been appointed to the chair of mathematics in the Newcastle Division of the University of Durham. Dr. Offord was born in 1906, and was educated at University College, London, and at St. John's College, Cambridge, where he was elected to a fellowship. He has also been a lecturer at the University College of North Wales, Bangor. He joined the Mathematics Department at King's College, Newcastle-upon-Tyne, in 1941. His published work includes papers on the theory of divergent series, Fourier transforms, trigonometric intervals and the application of methods of the theory of probability to algebraic equations; he has also done work on integral functions.

Mr. W. H. F. Barnes has been appointed to the chair of philosophy in the Durham Division of the University of Durham. Mr. Barnes is thirty-six years of age. He was educated at Corpus Christi College, Oxford, where he was awarded the Haigh Scholarship in classics and the John Locke Scholarship in mental philosophy. He also held for two years a Senior Demyship at Magdalen College. Since 1936 he has been assistant lecturer and then lecturer in philosophy at the University of Liverpool. During 1941–42 he was in the R.A.F. and thereafter took a post as administrative officer in the Ministry of Supply. His published works include papers in periodicals on values, meaning and verifiability, action, Berkeley and Locke, and Richard Price.

University of London : Appointments

The following appointments have been made in the University of London: Mr. Raymond Irwin, county librarian of Lancashire, to be director of the School of Librarianship at University College; Dr. John Yudkin, recently supervisor in biochemistry and physiology at Christ's College and Emmanuel College, Cambridge, to the University chair of physiology tenable at King's College of Household and Social Science; Dr. L. Dudley Stamp, since 1926 Sir Ernest Cassel reader in economic geography at the London School of Economics and Political Science, to the chair of geography at the School.

Announcements

Dr. H. J. Gough, who has just been released by the Ministry of Supply (*Nature*, Aug. 11, p. 168), is joining Lever Brothers and Unilever Ltd. as engineer-in-chief, and will shortly take up his duties at Unilever House.

The Nuffield Foundation has made a grant of £1,045 a year for five years for the stipend and pension contributions of a special research fellowship for Dr. E. Orowan to enable him to continue his work in the Cavendish Laboratory, Cambridge, on the plastic properties of metals; in addition, the Foundation will provide £455 a year for the same period towards the cost of the fundamental research work undertaken by him.

The next three graduate memberships of the Royal Institution, open to recent graduates, of either sex, of any university in the British Empire who have taken a degree with either first or second class honours in any scientific subject, will shortly be awarded by the managers of the Institution. These memberships give the holder the privileges of attending all lectures delivered in the Institution and the use of the Library. Application forms can be obtained from the General Secretary, Royal Institution, 21 Albemarle Street, London, W.1.

The Gas Light and Coke Company has decided to broaden the basis of its research programme and to arrange for improved co-ordination of effort within the Company. Dr. H. Hollings, hitherto the chief gas chemist of the Company, has been appointed controller of research, and he now becomes responsible for the activities of Watson House as well as those of the Fulham Research Laboratory. The following further appointments have also been made: Mr. W. Dieterichs to be manager, Watson House; Mr. G. C. Holliday to be manager, Gas Light Centre; Dr. R. H. Griffith to be senior research chemist; Dr. S. Pexton to be senior chemical engineer.

At the annual meeting of the Genetical Society, the following officers were elected: *President*, Dr. C. D. Darlington; *Vice-Presidents*, Prof. R. A. Fisher, Mr. M. B. Crane and Dr. J. Hammond; *Acting Treasurer*, Dr. D. G. Catcheside; *Secretaries*, Mr. W. J. C. Lawrence, John Innes Horticultural Institution, Mostyn Road, Merton, London, S.W.19; and Mr. R. R. Race, Galton Laboratory Serum Unit, at the Department of Pathology, University of Cambridge.

Mr. J. E. C. Bailey, chairman and managing director of Baird and Tatlock (London), Ltd., has been elected president of the Scientific Instrument Manufacturers' Association of Great Britain in succession to Mr. Frank Wakeham, who retires after three years of office. Mr. Bailey is a member of the Admiralty Chemical Advisory Panel, of the Commission on Scientific and Laboratory Equipment of the Conference of Allied Ministers of Education, and of several committees of the British Standards Institution. Other officers of the Association are: *New Vice-Presidents:* Mr. J. Hasselkus (Ross, Ltd.), Mr. Frank Wakeham (Cambridge Instrument Co., Ltd.), Mr. T. J. Offer (Chas. Baker); *Hon. Treasurer:* Mr. S. Borthwick (R. and J. Beck, Ltd.); *Hon. Secretary:* Mr. G. A. Whipple (E. R. Watts and Son, Ltd.); *Members of Council:* Mr. H. A. Carter (J. H. Dallmeyer, Ltd.), Mr. G. A. Heed (A. Kershaw and Sons, Ltd.), Mr. A. J. Hughes (Henry Hughes and Son, Ltd.), Mr. J. Loxham (The Sigma Instrument Co., Ltd.), Major G. McAlpine (Kelvin, Bottomley and Baird, Ltd.), Mr. E. C. Sherren (United Kingdom Optical Co., Ltd.); Mr. M. H. Taylor (Taylor, Taylor and Hobson, Ltd.), Mr. H. A. C. Trepte (W. and J. George and Becker, Ltd.), Mr. W. N. Wheat (Chance Bros., Ltd.), Mr. H. H. Zeal (G. H. Zeal, Ltd.).

Erratum.—In the communication "Abnormal Lignification in the Wood of some Apple Trees", by Dr. A. Beryl Beakbane and Dr. Eleanor C. Thompson, in *Nature* of August 4, p. 145, Fig. 1 has been inverted; that is, the section of the 'rubbery' branch is that marked (*a*).

LETTERS TO THE EDITORS

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

Penicillin in Leishmania Infections

THE action of penicillin on leishmania infections has not so far been reported in the literature. This note deals with the treatment of four hamsters infected with an Indian strain of the parasite which has previously been employed by me in chemotherapeutic tests[1]. The methods used were the same as those already described. The Golden Hamster (*Cricetus auratus*) is the most suitable animal for experimental studies of this infection, since in their case the disease, so far as is known, never shows spontaneous regression and finally causes death. The *in vitro* action of penicillin on tissue forms of the parasite and on flagellate forms in young and old cultures is also described. Thanks are due to the Penicillin Clinical Trials Committee of the Medical Research Council for a supply of material.

The animals weighed 60–80 gm. Two were treated with the calcium salt of penicillin in saline three times daily over a period of eight days with doses of 400 Oxford units at 3–4 hour intervals, partly by the intraperitoneal and partly by the subcutaneous route. Two others received half this amount in the same way, the total dose for each of the two pairs being 9,600 and 4,800 Oxford units respectively, which corresponds to 6–3 million units for a man of normal weight. The drug was tolerated without any untoward symptoms. The spleen infections before treatment varied from 5 to 200 Leishman-Donovan bodies per field, as seen under oil immersion with a × 10 eyepiece, and when smears were examined five days after the end of treatment it was found that the infections had progressed in the same way as those in two control animals. The drug had therefore exercised no influence on the course of the infection and parasitic cell division had taken place normally. In the case of bacteria, Bigger[2] has suggested that penicillin affects only dividing cells. Garrod[3], from his experiments, considers that the evidence on this point is conflicting. It is, however, not certain that the drug can penetrate the splenic cells which normally contain these tissue forms.

In four *in vitro* experiments, infected splenic tissue from hamsters was cultured for six to seven days in media at 25° C. which contained penicillin in various dilutions. A suitable number of control tubes were used at the same time. The results are recorded in Table 1. Accurate counts of flagellates could not readily be made since they tend to become agglutinated in masses under these conditions.

From Table 1 it will be seen that development of flagellates took place in all the culture tubes in which the concentration of penicillin was less than 50 units per c.c., and growth proceeded as in the controls. At that concentration flagellates failed to develop in some tubes and the percentage of failures increased with higher concentrations of drug. It should be noted that the upper concentrations are greater than those likely to be obtained in the blood in clinical practice. After seven days incubation it was found by the agar-cup method that in the highest concentrations about 50 per cent of the penicillin originally present had disappeared. According to Bigger, the maximum effect of penicillin is exerted near body temperature, but culture of leishmania at 37° C. has not so far been found possible. The results suggest that the drug in the highest concentrations used had exerted some action on the parasite, but our penicillin sample contained only 150 Oxford units per mgm. and the impurities present may have influenced the results.

TABLE 1. HAMSTER SPLEEN INFECTED WITH *L. donovani* CULTURED IN PRESENCE OF PENICILLIN.

Units of penicillin per c.c. of medium	No. of experiment				Totals
	1	2	3	4	
400				5−	5−
200			5−	2+ : 2−	2+ : 7−
50	2+ : 2−	1+ : 4−	5+	7+	15+ : 6−
12·5	3+	6+	6+	7+	19+
3·2		6+	6+		12+
0·8		4+	6+		10+
0·2		5+	6+		11+
Controls	3+	6+	4+	5+	18+
No. of parasites per field in each hamster spleen cultured	1	300	200	40	

+ = active flagellates present.
− = flagellates absent.

Some further experiments were made with flagellate cultures of different ages. Inocula of equal size of young flagellate cultures were sown in media containing penicillin at similar concentrations to the above, as well as in control tubes. After incubation at 25° C. for six to seven days, the contents of the tubes were examined and rough counts made of the number of flagellates present. It was found that the flagellates in tubes containing penicillin were as active as, and their numbers differed but little from, those in the control tubes. These results are summarized in Table 2.

TABLE 2. ACTION OF PENICILLIN ON FLAGELLATE FORMS OF *L. donovani* IN CULTURE MEDIUM.

Units of penicillin per c.c. culture medium	400	200	50	12·5	3·2	Controls
Total no. of tubes used for each conc. of drug	8+ : 1−	13+ : 1−	13+	13+	4+	10+

+ = active flagellates present.
− = flagellates absent.

It will be seen from Table 2 that only in two tubes containing penicillin did flagellates fail to survive six days. We consider that the drug had no action on these forms even at the high concentrations used.

In a final experiment penicillin, in the same medium, was added to six-day old cultures of flagellates to give a concentration of 400 Oxford units per c.c. Four tubes maintained at 25° C. for four days showed no diminution in numbers or activity compared with controls.

J. D. FULTON.

National Institute for Medical Research,
London, N.W.3.
July 10.

[1] Fulton, J. D., *Ann. Trop. Med. and Parasitol.*, **38**, 147 (1944).
[2] Bigger, J. W., *Lancet*, **247**, 497 (1944).
[3] Garrod, L. P., *Brit. Med. J.*, 107 (Jan. 27, 1945).

A Thermostabile, Fungistatic Factor from *Escherichia coli*

When cultivating *Penicillium notatum* Westl. and related fungi for the purpose of producing penicillin, it was soon noticed that the production of penicillin was inhibited by certain bacteria. It was proved that this was due to the fact that the bacteria in question formed an apparently enzymatic substance able to destroy penicillin. This substance, which was called penicillinase, was first demonstrated by Abraham and Chain[1] in *Esch. coli* and *M. lysodeikticus*. It was later found in paracolon bacilli[2], in *B. subtilis*[3,4], in penicillin-resistant staphylococci[5], as well as in various other micro-organisms[6,7,8]. In addition, commercial preparations of taka-diastase and clarase were found to have a similar effect[9,10]. Preparations of penicillinase, like those of other enzymes, are more or less thermolabile. The penicillinase from *Esch. coli*, for example, is easily destroyed by heat[1], whereas that from *B. subtilis*, on the other hand, seems to be more stable[3].

Occasionally the production of penicillin was found to be partly or completely inhibited from other causes which could not be determined.

An interesting observation in this connexion was made here about two years ago in experiments with the cultivation of *Penicillium notatum*. In some cases, in which the nutrient medium was not sterilized immediately after its preparation, but was allowed to remain a short time at room temperature before autoclaving, the rate of growth of the fungus decreased, with the result that the production of penicillin also decreased. (Disturbances in the production of pigment by the fungus were also noted.) Evidently some species of the micro-organisms which had developed before the medium was autoclaved had produced a thermostabile substance with fungistatic activity.

In later experiments to determine the ability of a number of bacteria to produce a substance of this kind, it was found that a strain of *Esch. coli* possessed this ability to a marked degree, particularly when the following medium was used: asparagine 2 gm., $NaNO_3$ 3 gm., KH_2PO_4 6·5 gm., $Na_2HPO_4,12H_2O$ 33·5 gm., KCl 0·5 gm., $MgSO_4,7H_2O$ 0·5 gm., $FeSO_4,7H_2O$ 0·01 gm., glucose 40 gm., casein hydrolysate solution (Mueller) 2 ml., distilled water to 1 litre.

The growth of *Penicillium notatum* was excellent in this medium, which was sterilized by autoclaving at 120° C. for twenty minutes, and after about seven days at room temperature a compact layer had been formed which completely covered the surface of the medium in the culture vessels. But, if after sterilization the medium was inoculated with *Esch. coli*, incubated at 37° C. for 24 hours, and autoclaved again at 120° C. for twenty minutes, the rate of growth of the fungus was found to be greatly reduced. Not until about seven days after inoculation could signs of growth be observed in the form of small, scattered, star-like, white figures around the wall of the vessel at the level of the surface of the medium. The later growth was also very slow.

The differences in the sugar concentration and the *p*H, respectively, between the medium in which *Esch. coli* had been cultivated and the original medium were not significant, and the reduction in the rate of growth can therefore not have been due to any variation in these respects. It was also proved that with the exception of the inoculation with *Esch. coli* the treatment of the medium (incubation at 37° C. and autoclaving) did not cause the inhibition of growth. Since all the substances necessary for normal growth were present, some fungistatic factor, which also was thermostable, must have been produced.

This fungistatic factor can be produced in other media also, for example, broth, but not to the same extent as in that stated above.

The factor in question was found to be without any effect in the assay of penicillin by the cylinder-plate method (modified according to Wiedling[11]). It thus differs from penicillinase not only in its thermostability, but also in that its effect on the production of penicillin is caused by a reduction in the rate of growth of the fungus and not by actual destruction of the penicillin. The thermostability of the factor also distinguishes it from most other bacterial fungistatics, which usually are thermolabile[12].

Sten Wiedling.
Central Laboratories of AB. Astra,
Södertälje, Sweden.
April 28.

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A New Occurrence of the Electronic Phase Velocity

Starting with the Lorentz equation:

$$\frac{d}{dt}(m\mathbf{v}) = e\left\{\mathbf{E} + \frac{[\mathbf{vH}]}{c}\right\} \quad . \quad . \quad . \quad (1)$$

we have, after scalar multiplication by $\mathbf{v}$, which is at right angles to the vector product $[\mathbf{v},\mathbf{H}]$,

$$\frac{d}{dt}(\tfrac{1}{2}mv^2) = e\mathbf{vE} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Replacing $\mathbf{E}$ in terms of φ and $\mathbf{A}$,

$$\frac{d}{dt}(\tfrac{1}{2}mv^2) = -e\left(\mathbf{v}\nabla\varphi + \frac{\mathbf{v}\dot{\mathbf{A}}}{c}\right); \quad . \quad . \quad (3)$$

where $\mathbf{A}$, the vector potential, satisfies

$$\mathbf{H} = \text{curl}\,\mathbf{A} \text{ and } \nabla A + \dot{\phi}/c = 0 \quad . \quad . \quad . \quad (4)$$

We next write in (3) for its rearrangement

$$\mathbf{v}\nabla\varphi = \frac{d\varphi}{dt} - \dot{\varphi}, \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

so that the total energy changes at the rate

$$\frac{d}{dt}(\tfrac{1}{2}mv^2 + e\varphi) = e\dot{\phi} - \frac{e\mathbf{v}\dot{\mathbf{A}}}{c}. \quad . \quad . \quad . \quad (6)$$

Now, using (4), this may be written

$$\frac{d}{dt}(\tfrac{1}{2}mv^2 + e\varphi) = -ec\left(\nabla\mathbf{A} + \frac{\mathbf{v}}{c^2}\dot{\mathbf{A}}\right) \quad . \quad (7)$$

Next, let us seek the consequences of supposing $(\frac{1}{2}mv^2 + e\varphi)$ to be constant, both in space and time. This means, from (7),

$$\nabla\mathbf{A} + \frac{\mathbf{v}\dot{\mathbf{A}}}{c^2} = 0; \quad . \quad . \quad . \quad . \quad (8)$$

also

$$m\mathbf{v}\dot{\mathbf{v}} + e\dot{\phi} = 0. \quad . \quad . \quad . \quad (9)$$

Adding (9) to ec times (8) we have :

$$\mathbf{v}\left(\dot{m}\mathbf{v} + \frac{e\dot{\mathbf{A}}}{c}\right) + ec\left(\nabla\mathbf{A} + \frac{\dot{\phi}}{c}\right) = 0. \quad . \quad (10)$$

But, by (4), the last bracket vanishes. Thus, aside from the trivial result $\mathbf{v} = 0$, we are left with

$$\dot{\mathbf{p}} = 0, \quad . \quad . \quad . \quad . \quad . \quad . \quad (11)$$

where

$$\mathbf{p} = m\mathbf{v} + \frac{e\mathbf{A}}{c} \quad . \quad . \quad . \quad . \quad (12)$$

$\mathbf{p}$ is the sum of the mechanical and electromagnetic momentum associated with each particle. Thus, in order for the energy of a particle to be conserved, (11) must hold good ; but this need not mean that both $\dot{\mathbf{v}}$ and $\dot{\mathbf{A}}$ must separately vanish. Thus $\dot{\phi}$ need not be zero in (9), so that $\nabla\mathbf{A}$ need not be zero. Then (8) may be regarded as having a non-trivial solution. If the variable part of $\mathbf{v}$ is small compared to the part which is constant in time and space, a close approximation to this solution is the plane wave

$$\mathbf{A} = \psi(\mathbf{s} - \mathbf{u}t), \quad . \quad . \quad . \quad (13)$$

where

$$\mathbf{u} = c^2/\mathbf{v}, \quad . \quad . \quad . \quad . \quad . \quad (14)$$

ψ is any function of the argument shown and $\mathbf{s}$ is the vector distance.

Now if the beam is moving in a straight line, curl $\mathbf{u} = 0$. Provided $\mathbf{A}$ is directed along $\mathbf{s}$, we shall then have curl $\mathbf{A} = 0$. But this means no Poynting vector. Hence, for a beam of electrons moving with nearly uniform velocity in a straight line, electronic waves of a kind are predicted. These are A waves, yet carry no energy away provided $\mathbf{A}$ is directed tangential to the path of the electrons, which is also A's direction of propagation with wave velocity $\mathbf{u}$ and group velocity $\mathbf{v}$.

In view of experiments leading us to infer for electronic waves properties precisely the same as those postulated for the electronic A waves, our discovery of these is perhaps not to be regarded as fortuitous.

If we regard the arbitrary part of the phase as governed by the experimental result

$$\lambda = h/mv, \quad . \quad . \quad . \quad . \quad . \quad (15)$$

our solution may be written in the form

$$\mathbf{A} = \mathbf{s}_1\psi\left(\frac{mc^2}{\hbar}t - \frac{mvs}{\hbar}\right), \quad . \quad . \quad (16)$$

where $\hbar = h/2\pi$; $\mathbf{s}_1$ is a unit vector along $\mathbf{s}$.

In order to obtain $\mathbf{A}$ as a wave of velocity c, such as is obtained in atomic and wireless radiation, it is necessary to depart from the principle that $\frac{1}{2}mv^2 + e\varphi$ is constant. The terms on the right-hand side of (6) then yield radiation of known type, of which the A-dependent part may travel to great distances ; but before such result is obtained it is necessary to sum over all particles present in the field.

I should like to thank Prof. H. T. Flint for his interest and for suggesting the title of this note.

W. E. Benham.

Holt's Crest,
Fordcombe,
Nr. Tunbridge Wells.
May 18.

Chromatography of Two Solutes

The communication by Drs. Offord and Weiss[1] is of particular interest to me, as I am just publishing a paper on the same subject, though with different results.

Using the same definitions, we have the adsorption isotherms

$$q_1 = f_{(c_1c_2)} \quad , \quad q_2 = g_{(c_1c_2)} ;$$

whence it follows from de Vault's equations[2] that

$$\frac{df_{(c_1c_2)}}{dc_1} = \frac{dg_{(c_1c_2)}}{dc_2} = \frac{v}{x} \quad \text{(see Offord and Weiss's equation 2)} \quad (1)$$

Equation 1 defines the relationship between c_1 and c_2 in that part of the chromatogram where the concentrations vary. But without a complete solution of this simultaneous differential equation, no useful deductions can be drawn. Offord and Weiss's equation 3 for v/x which, if correctly deduced, should read :

$$v/x = g'_{(c_2)} -, \text{ etc.} \quad (1.1)$$

unfortunately has no meaning, as it refers to definite sets of c_1 and c_2 (defined by eq. 1) and, without an integration, there is no way of knowing which value of c_1 belongs to any given c_2.

Fortunately, the only adsorption isotherm which offers a theoretically founded relationship between the amounts of multiple solutes adsorbed and in solution—the Langmuir isotherm—does permit of a solution of equation 1, resulting in a linear relation between c_1 and c_2.

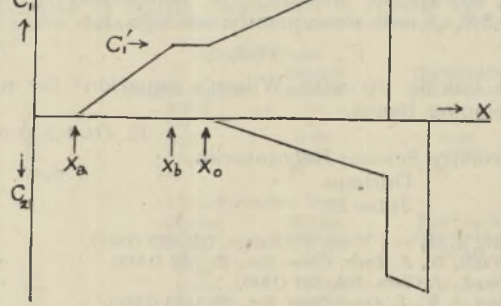
Taking $f = a_1c_1/(1 + b_1c_1 + b_2c_2)$ and $g = a_2c_2/(1 + b_1c_1 + b_2c_2)$ where $a_1 > a_2$, the solution of equation 1 is :

$$a_1b_2c_2 = a_2b_1c_1.\lambda - (a_1 - a_2)\lambda/(1 + \lambda), \quad . \quad (2)$$

where λ is an integration constant obtainable from equation 2 by inserting the initial conditions c_1^0 and c_2^0. This gives a quadratic equation with a positive and a negative root for λ. One of these applies according to whether dc_1/dc_2 is positive (trailing boundary of the less adsorbed material) or negative (forward boundary of the more strongly adsorbed material).

Equation 2 makes it possible to calculate exactly and in detail every stage in the development of the chromatogram, and this has been done in the paper referred to. After the disappearance of the original constant levels, the distribution is shown in the diagram (where diffusion phenomena which would reduce the sharpness of the front boundaries are not considered).

The chromatogram shown has three distinct parts : a pure frontal band of pure solute II, a mixed band,



and a rear band of pure solute I. The statement by Offord and Weiss that the same solute may appear both in the front and rear bands if its concentration greatly exceeds that of the other solute certainly does not apply to this type of isotherm. This phenomenon is not general, but occurs only when the two isotherms intersect, and when thus the same solute is more strongly adsorbed at low concentrations (rear) and less adsorbed at high concentrations (front).

Offord and Weiss's equation for the amount of pure solute in the tail band does not, as claimed, represent the total content, but only the amount between x_a and x_b. Consequently, their equation 7 for the volume of pure solvent required for total separation is also erroneous.

If the tail band containing pure solute I were not fed constantly from the mixed band, its forward edge would travel down the column in accordance with the equation :

$$\Delta v / \Delta x_0' = f_{(c_1' o)}/c_1' \quad . \quad . \quad . \quad . \quad (3)$$

(see Weiss[3]), while the rear end of the mixed band is given by

$$\Delta v / \Delta x_0 = f'_{(c_1' o)} = g'_{(c_1' o)} \quad . \quad . \quad . \quad (4)$$

where $f'_{(c_1' o)}$ and $g'_{(c_1' o)}$ stand for the complete differentials $[df/dc_1]_{c_2=0}$ and $[dg/dc_2]_{c_2=0}$ respectively.

To maintain a continuous chromatogram the amount fed into the tail band must therefore be

$$\Delta m_1 = (\Delta x_0 - \Delta x_0') \cdot f_{(c_1' o)} ; \quad . \quad . \quad (5)$$

whence it follows that, for complete separation, the volume V of solvent required is given by

$$m_1 = v^0 \cdot c_1^0 = V \cdot \left(\frac{f_{(c_1' o)}}{g'_{(c_1' o)}} - c_1' \right); \quad . \quad (6)$$

while the minimum length of column required for complete separation is

$$L = V/g'_{(c_1' o)} = m_1/(f_{(c_1' o)} - c_1' \cdot g'_{(c_1' o)}) \quad . \quad (7)$$

Equations 6 and 7 are, however, almost without practical value unless c_1' is known, and this can so far be calculated for Langmuir isotherms only, where

$$c_1' = (a_1 - a_2)/a_2 b_1 (1+\lambda) = \delta/b_1(1+\lambda), \quad . \quad (8)$$

where $\delta = (a_1 - a_2)/a_2$. This leads to

$$V = m_1 b_1 (1+\lambda)/\delta^2 \text{ and } L = m_1 b_1 (1+\lambda+\delta)/a_2 \delta^2. \quad (9 \text{ and } 10)$$

It follows from equation 2 that λ assumes simple values when $b_1 c_1^0 \gg \delta$ and when $b_1 c_1^0 \ll \delta$. In the first case, corresponding to solutes difficult to separate, $\lambda = a_1 b_2 c_2^0 / a_2 b_1 c_1^0 =$ approx. c_2^0/c_1^0 ; whence

$$V = \sim b_1 (m_1 + m_2)/\delta^2 ; \quad . \quad . \quad . \quad (11)$$

showing dependence on the combined amount of solutes to be separated. In the second case, where the adsorption intensity is comparatively low, $\lambda = \delta/b_1 c_1^0$ and consequently, as $\lambda \gg 1$,

$$V = v^0/\delta, \quad . \quad . \quad . \quad . \quad . \quad (12)$$

thus linking up with Wilson's equation[4] for non-developing bands.

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Anomalous Inactivation of Heavy Metal Antifouling Paints

The inactivation of antifouling paints in the neighbourhood of an exposed steel surface, referred to by Young and Seagren[1], has often been encountered by investigators of the Marine Corrosion Sub-Committee. Fouling on one or both sides of an unpainted 'holiday' (the location of the fouling being determined by the direction of tidal flow) is invariably accompanied by rust deposits in the fouled areas.

The cause of this inactivation is probably not connected with the interaction of the base metal with the heavy-metal poison ; indeed the phenomenon has been observed by us in paints which rely largely or entirely on organic poisons. The following explanation, based on the work of Dr. U. R. Evans[2] on metallic corrosion in salt solutions, appears to offer a sounder basis for interpreting the observations.

At some portions of a bare steel surface exposed to sea water, the metal becomes anodic to the surrounding (in this case painted) area, and from the anodic regions ferrous ions pass into solution. These diffuse outwards and in the presence of free oxygen and alkali arising from the cathodic reaction, form ferric hydroxide which becomes deposited as a rust coating. In still water the ferric hydroxide is formed in the boundary region between the anodic and cathodic areas, but in the presence of a water current the deposition of rust will spread in the direction of the current.

The antifouling properties of the coating will be affected in several ways by this process. In presence of the alkaline cathodic product, though the rosin matrix of the antifouling paint may be more rapidly dissolved, the solubility of the copper will be depressed in the presence of free OH' ions. It has been shown by extensive unpublished work in Great Britain and in the United States[3] that for a copper paint to be effectively antifouling, it must release its copper at a clearly defined minimum rate into the sea water ; if copper leaches out at a satisfactory rate under normal conditions, the effective toxicity of the paint will be greatly reduced in presence of alkali. The deposition of rust in the pores of the paint (which may be increased by cataphoretic action on the positively charged colloidal ferric hydroxide) will also tend to reduce the loss of copper from the surface.

In the initial stages of their life, many antifouling paints show an excessively high rate of loss of copper —this is particularly true of metallic copper paints— and the early freedom from fouling in Young and Seagren's experiments is not at all surprising. The production of alkali in cathodic regions will only occur over the painted portion of the plate when the paint is sufficiently swollen after long soaking to be electrolytically conducting ; alkali-softening of the paint, starting from the edge of the bare steel area, will spread outwards and progressively inactivate greater and greater areas of the painted surface.

There is thus no need to invoke the authors' hypothesis of inactivation by organic iron complexes ; it is doubtful if the conditions are such as to encourage their formation. Dr. M. F. Spooner found that the *p*H of slime films in our experiments was never lower than 7·5 ; the rust on the paint surrounding a bare metal 'holiday' appears within a day or two even on synthetic resin paints, which form slime films only a few microns in thickness at this early stage. A similar type of rust deposit on painted steel panels occurs in sodium chloride solution in the laboratory ;

and the mechanism of inactivation suggested above appears quite adequate to explain the effects observed.

The limited inactivation near an *insulated* steel block is therefore due to the fact that the cathodic as well as anodic areas will be on the bare steel, so that the above conditions for extensive deposition of rust on the adjacent paint surface do not exist; and inactivation of the antifouling composition will be restricted to the painted area immediately adjacent to the edges of the insulated plate.

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[3] The following paper on work in the United States has arrived in Britain since going to press. Ketchum, B. H., Ferry, J. D., Redfield, A. C., and Burns, A. E., *Ind. Eng. Chem.*, **37**, 456 (1945).

Amino-quinazolines

IN a journal which has recently reached us, Dewar[1] reports the preparation of the 2-amino- and 4-amino-quinazolines. In the course of work on the amino-benzadiazines and their sulphanyl derivatives carried out in these laboratories, we had also prepared the amino-quinazolines, but in some respects our results differ from those described by Dewar. Thus we obtained good yields of 2-amino-quinazoline from guanidine nitrate and O-amino-benzaldehyde, a method stated by Dewar to yield only traces of the desired product. The 4-amino-quinazoline we prepared by amination of the corresponding chloro-compound.

Our melting points for the substances are somewhat higher than reported by Dewar, the 2-amino- and 4-amino-quinazolines having melting points of 204° and 272° respectively.

The bases were coupled with sulphonyl chloride to give 2-sulphanilyl-quinazoline (m.p. 286°) and 4-sulphanilyl-quinazoline (m.p. 255·5°), but the compounds are too insoluble to have chemotherapeutic activity.

Full experimental details of the work will be published elsewhere.

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Influence of Sulphur Oxides on the Luminosity of Coal Gas Flames

IN the course of an investigation into the oxidation of sulphur dioxide in combustion reactions, forming part of a programme of work being carried out for the Boiler Availability Committee, some interesting observations have been made on the luminosity of coal-gas flames to which sulphur oxides had been added.

When sulphur dioxide was added in small quantities to a luminous smoky flame, the luminosity decreased and completely disappeared after about 5 per cent by volume of sulphur dioxide had been added. The flame showed a purple colour, and when a cooled funnel was held above the flame a yellowish-white deposit collected. Physical and chemical tests showed this to be sulphur. Spectroscopic examination of the flame revealed that a series of bands was present which appeared to be due to S_2 molecules. 5 per cent of sulphur dioxide added to a normally aerated bunsen flame shortened the outer cone and imparted a purple colour to this normally dark-blue region.

The addition of sulphur trioxide, on the other hand, increased the luminosity of coal-gas flames. When the port on the burner was adjusted so as to give an almost luminous flame, the introduction of 0·1–0·2 per cent by volume of sulphur trioxide brought about an immediate increase in luminosity. The same effect is observed in an aerated flame but the amount of trioxide required was of the order of 1 per cent. Whether this increased luminosity is due to emission from carbon particles produced by reactions involving the sulphur trioxide and the hydrocarbons present in the gas or to some other cause has not yet been established.

A detailed account of these results and of the behaviour of sulphur oxides in combustion reactions will be published shortly.

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Distribution of Vanadium, Chromium, Cobalt and Nickel in Eruptive Rocks

THE similarity, pointed out by P. H. Lundegårdh in a recent communication[1], between the amounts of the above trace elements in the normal series of igneous rocks from Eastern Upland, Sweden, and those in the corresponding members of the suite of rocks which we have analysed from the Skaergaard Intrusion, East Greenland[2], is of considerable interest in view of the differences between the two series of rocks. In describing our results, we offered tentative explanations of the observed variations in the trace constituents, based largely on V. M. Goldschmidt's earlier work, and we shall look forward to Lundegårdh's further treatment of the problem in view of his new data from Sweden.

In the meantime, it may be of interest to record some data, recently obtained, which indicate the actual location of the trace constituents in some of the minerals which make up certain of the Skaergaard rocks. From these data, we select the following for olivines and clino-pyroxenes separated from rocks previously analysed in bulk and quoted by Lundegårdh.

PERCENTAGE OF CERTAIN CONSTITUENTS IN OLIVINES AND CLINO-PYROXENES SEPARATED FROM ROCKS OF THE SKAERGAARD INTRUSION.

	Olivines from:		
	Gabbro picrite	Olivine gabbro	Hortonolite ferrogabbro
V	0·003	—	—
Cr	0·1	—	—
Co	0·01	0·01	0·01
Ni	0·1	0·04	0·001
Fe_2SiO_4	19	37	60

	Clino-pyroxenes from:		
	Olivine gabbro	Middle gabbro	Hortonolite ferrogabbro
V	0·01	0·01	0·003
Cr	0·04	—	—
Co	0·004	0·006	0·004
Ni	0·008	0·005	—
$FeSiO_3$	19	36	50

In the table a dash indicates that the amount present is less than the sensitivity of the spectrographic method employed, namely, vanadium 0·0005 per cent, chromium 0·0002 per cent, cobalt 0·0002 per cent, nickel 0·0002 per cent. The order in which the rocks are given is the order of their formation.

Plagioclase felspars have also been separated and other minerals are in the process of being separated and analysed.

The microscopic and field evidence indicates that the rocks selected for analysis represent, as closely as can be expected under natural conditions, crystal fractions from a single slowly cooling magma. The amounts of the trace constituents are in this case apparently controlled by the ease with which the trace elements enter the various crystal phases, and we must turn to the crystal chemist for a detailed consideration of the factors involved. The rocks of the Skaergaard Intrusion and the minerals composing them provide data on the kind of changes in the trace constituents which occur as a result of strong fractional crystallization differentiation of basic magma, and this should form a useful starting point in attempts to understand the variation in the trace constituents of rock suites having a more complex petrogenetic history.

Possible practical applications of results such as these include the diagnosis in soils, purely from a geological examination, of deficiencies or excesses, which may be of importance for problems of plant and animal nutrition.

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June, 1945

[1] *Nature*, **155**, 753 (1945).
[2] Wager and Mitchell, *Min. Mag.*, **26**, 283 (1943).

Economy in Sampling

The method described by Haldane[1] for estimating the fraction p of a population having the attribute A is a particular instance of a more general theory which has been used in this department and elsewhere since 1943.

The statistical methods of assessing trial results in use before the War were for the most part developed in connexion with biological problems, where there is often present a limitation not found in other fields, namely, that the sample size for a proposed experiment must be determined in advance, before the experiment is actually begun. When such a limitation is unnecessary, it is found more efficient usually to plan a statistical *procedure*, and an associated test, for determining the question at issue.

For example, if we want to compare two designs, A and B, of an instrument, with regard to their comparative effectiveness, the classical procedure would suggest A be tried m times and B be tried n times, under similar conditions, and the numbers of successes observed for each design:

	1 Success	2 Failure	3 Total
Design A	a	c	m
Design B	b	d	n
Total	r	s	N

If we assume that, under the given conditions, A has a constant probability of success p_1 and B has constant probability of success p_2, then the null hypothesis $p_1 = p_2$ can be tested by a method which I have developed, or by a method due to Fisher[2], which, on the null hypothesis, associates with the above table a probability $m!n!r!s!/N!a!b!c!d!$. These tests correspond to the procedure in which column 3 of the table is fixed in advance, and columns 1 and 2 are filled in from the experimental results.

We may, however, be able to fix, say, column 2 in advance, and allow the experimental results to determine 1 and 3. In this case, by a procedure exactly analogous to Fisher's, we find that the probability on the null hypothesis associated with the above table is $(m-1)!(n-1)!r!s!/(N-1)!a!b!(c-1)!(d-1)!$, and we can construct a significance test accordingly. For large m and n there is a continuous approximation, which takes the form of the variance ratio function F, analogous to the χ^2 approximation in the classical case. There is also a correction for continuity, analogous to that of Yates[3].

In order to compare the efficiency of this test with that of the classical procedure, we have to compare at the mean sample size, since the actual sample size with the new procedure is not fixed. Consideration of the power for given mean sample size then shows that, when at least one of the two probabilities involved is small, the new test is much more powerful than the classical test. The power-ratio is not fixed, but for suitable values of p_1 and p_2 may increase without limit.

Similar considerations can be applied to all other kinds of statistical test. Broadly speaking, when the statistician was asked by the experimenter the question "How many items should I take for my sample ?" it was often difficult to give a reasonable answer, since this would often depend on knowledge which could only become available after the result was known. By making sample size one of the variables which are determined in the course of the experiment itself, it is possible for the statistician to tell the experimenter: "If you follow this procedure, you will determine the issue involved just as soon as your results allow". From a passive role involving static planning and subsequent testing of results obtained, statistical theory acquires an active role, entering into the experimental process itself.

In developing tests for other situations, it is found that the statistical theory involved is closely connected, on one hand with the classical theory of games, as studied by de Moivre[4], Laplace and others, and on the other hand, with the theory of diffusion processes. In particular, the statistical tests involved in many consumer's inspection problems are direct generalizations of the classical problem of the "Ruine des Joueurs", in the qualitative case, while the continuous measurement case corresponds to a linear diffusion problem with fixed absorbent boundaries.

This work has been carried out as part of the programme of the Ministry of Supply.

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May 11.

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IS HUMAN SPEECH GOOD ENOUGH?*

By Sir RICHARD PAGET, Bart.

THE answer to the query in the title depends on what we mean by human speech—and what we mean by good enough!

Very few ideas can be directly expressed by sounds; sound itself is not an essential of human speech—we can speak (to ourselves) and express meaning simply by making the motions of 'articulation', without producing any sound; deaf people who have learnt the art of lip-reading can understand such silent speech, by watching the gestures of articulation. It is therefore the gestures rather than the sounds of speech which carry meaning; the functions of sound, in speech, are to enable its meaning to be identified by ear.

The gestures of articulation are fundamentally pantomimic, and this pantomime is made audible by the vibration of our vocal cords—to produce 'voiced' sounds; or by blowing air through our vocal cavities—to produce the 'unvoiced' speech sounds. The gestures of articulation modify these voiced or unvoiced sounds in much the same way as the manipulation of the keys, slides, etc., of a musical wind instrument modify its sounds; just as a skilled trombone player could, with his eyes shut, visualize the gestures of another trombone player by simply listening to his playing, so we, subconsciously, recognize a speaker's gestures of articulation by listening to his speech. The voiced and unvoiced sounds of speech are the relics of the original emotional language of mankind.

The origin of mouth pantomime may be recognized in the born deaf; they naturally express their ideas by bodily pantomime—mainly hand pantomime—which they enrich with facial expression. Some form of emotional expression is essential if we are to succeed in making our fellow men think as we want them to.

The combination of hand pantomime and emotional sounds eventually produced speech because of the Darwinian "imitation or some kind of sympathy" between the movements of man's hands and mouth (Darwin, "The Expression of the Emotions" (1872), p. 34). Alfred Russel Wallace, in an article in the *Fortnightly Review* during 1895, wrote: "Speech was formed and evolved . . . by men and women who felt the need of a mode of communication other than gesture only. Gesture-language and word-language doubtless arose together, and for a long time were used in conjunction and supplemented each other".

It follows that as primitive man pantomimed, his mouth—without his knowledge—took part in the pantomime; the result must have been a 'gabble' of speech-like sounds due to the changes of the volume and size of orifice, and the constrictions and stoppages of the vocal cavities, and to the changes of the tone of voice caused by changes of emotional state.

In general pantomime, the sequence of gestures does not represent a succession of words—it describes actions or states as a whole. This stage of general pantomime, accompanied by mouth gabble, may have been man's normal mode of expression during the greater part of his million or half-million years of prehistoric development.

According to Prebendary Albert Smith, chaplain to the Royal Association in aid of the Deaf and Dumb, the uneducated born deaf still do not think in the same way as hearing people. They have no signs comparable to our words; their impressions are generalized (like their pantomime) and they cannot define anything, because they have no units with which to define. This is a point of the utmost importance. It distinguishes the career of primitive man from that of *Homo sapiens*, the analytical thinker of the last six or eight thousand years. At some point in his unrecorded history, man must have hit upon a new way of mentally handling his impressions; he separated them into categories, such as shape, colour, number, etc., and symbolized each separate element by a distinctive pantomimic sign. He could then begin to play with units of thought, transposing and recombining them in his mind, so as to arrive at new combinations and inventions.

This is admittedly hypothesis; but it offers a reasonable explanation of man's sudden and rapid advance in civilization. It was not man's brain which suddenly changed, but his way of using his brain.

The discovery, by primitive man, of the new method of analytic symbolism must have led, by slow degrees, to a new type of sign language composed of separate signs equivalent to modern words, performed in a more or less logical order, such as the Red Indian sign language.

The gesture theory of speech has recently received powerful support from Prof. Alexander Jóhannesson, of Reykjavik University, Iceland, who sent me a statement of which the following is a summary: In a twelve-years study of the Icelandic language (old and new) Prof. Jóhannesson examined every Indoeuropean root and found the etymology of about 20,000 words. It became gradually clear that a great many roots showed a primary meaning which was in accordance with the nature of the sound. In 1943 he published (in Finnish) his book "On the Primitive Language of the Indoeuropean People", in which he explained about 25 per cent of the whole Indoeuropean material and showed that a great part was due to imitation by the speaking organs of the movement of the hands. Having written about half of his book, my "Human Speech" came into his hands; he was delighted to see that, by studying the nature of the sounds, I had come to nearly the same results as he had by comparative philology. He was encouraged by my work and was now able to explain the majority of the Indoeuropean roots as gesture; he was highly satisfied to find the gesture theory confirmed also in Hebrew (in certain sound-groups he easily explained 60 per cent). He believes that my gesture theory will be of great importance for philology, and regards the problem of the birth of language in its chief principles as solved. Philology will take its place among the other sciences in the evolution of man. He is convinced that an international auxiliary language—which will be much needed in the near future—can only have a prospect of success if constructed in accordance with this new knowledge.

Here I must make one disclaimer: I did not originate the gesture theory; this was, I believe, originally propounded by Mr. J. Rae, of Honolulu, in three articles written, in 1882, for the *Polynesian* newspaper. Mr. Rae's work was referred to by Prof. Max Muller at a Royal Institution lecture on the science of language in 1863. His theory was not then described, but the British Museum had a bound volume of the *Polynesian* and the articles were reprinted as an appendix to my "Human Speech".

As to the question, "Is human speech good enough?", the answer, considering the appalling

* Substance of Friday discourse at the Royal Institution, delivered on March 23.

confusion into which this world has been thrown, largely by muddled thinking and perpetual misunderstandings, must surely be: No! We needed something more precise—more quantitative and less ambiguous—something which will advance human mentality as mathematics has advanced physical science and technology. The mystery and magic of human speech need no longer block the way. The late Prof. Otto Jespersen ("Mankind, Nation and Individual from the Linguistic Point of View", 1925) emphasized the duty of improving language for the sake of future generations, and said that "that language is best which, at every single point, is easiest to the greatest possible number of human beings".

English—though probably the best language yet evolved—is still very imperfect. Thus: 'to understand' does not mean 'to stand under'; 'to learn by heart' does not mean 'to learn by means of the heart'; 'to undertake' does not mean 'to take under'. As to changes of articulation in course of time, the so-called 'sound shifts' are mainly only 'exhibits' of the principle of 'least effort'. The organs of articulation tend to make their gestures easier to perform; voiced sounds become unvoiced, tongue postures are shifted to accommodate the accompanying consonant gesture, etc. Generally speaking, although 'least effort' is ever present, the significant gestures tend to be preserved, though the manner of making them may be modified.

As to verbal inflexions, English has discarded all the Germanic forms except that of the third person singular of its verbs—this hissing 'relic of barbarism' should be removed! Grammar itself is a relic of barbarism; it probably had its origin in sign language. Thus, it is easy to combine, say, the sign for 'come' with the finger signs for 1 or 2 or many, so as to sign one person come, two come, or many come. Mouth gesture cannot imitate these combined hand gestures; new arbitrary mouth gestures are substituted, and language becomes burdened with singular, dual and plural forms of its verbs.

Both English language and spelling need reform. Prof. Gilbert Murray, who is president of the Simplified Spelling Society, in a letter to me wrote: "I very much agree with you that English is so nearly a good language that it really ought to be looked after". If all children were taught something about the present *imperfections* of English, and were initially taught a rational system of spelling, reform would come of itself in another generation; if all children (throughout the world) were taught sign language—as a form of play—there would be one auxiliary international language available within the next twenty years. The British Commonwealth and the United States should join in appointing two English-speaking commissions, one to study the language, the other the spelling. Sufficient unification of pronunciation could easily be achieved through educational talking films and broadcasting.

The following are suggested as essential requirements: (1) Audibility. This implies that the unvoiced speech sounds should be eliminated, as being utterly inferior in audibility and in musical and emotional value. Also that accuracy of articulation should be considered as important as finger technique is in the playing of musical instruments. (2) Every word should be the result of a gesture of articulation which is pantomimically related to the meaning of the word. (3) Every word should be invariable in its form, and capable of use as any part of speech—as in Chinese. (4) Every root word should be monosyllabic. (5) The word order should be strictly logical—it is absurd to invert the word order to denote a question (as in English). (6) Homophones should be eliminated. (7) The spelling should be systematic—with a separate alphabetical symbol for each separate sound.

The development of an international auxiliary language on these principles has been carried near to completion by Mr. Kenneth Littlewood. It is named 'Monling', and was expected to be ready for the printer shortly. The sentence "The best language is that which is easiest to learn and use" becomes, in 'Monling', "Ling 't top pai ken ad ploi il klar top bon"—where ' represents the English indefinite vowel, like the 'e' in "the king" or the 'a' in sofa.

CHEMOTHERAPY OF TUBERCULOSIS

By Dr. M. A. SOLTYS
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SINCE Ehrlich's discovery of 'Salvarsan' there have been several attempts to seek a chemotherapeutic drug for the treatment of many infectious diseases. Of all the chemical substances studied in the chemotherapy of tuberculosis, calcium and gold compounds have probably attracted more attention over a longer period of time than any others. Maver and Wells[1], from their intensive investigations, came to the conclusion that calcium does not support the conception of a favourable influence on the course of tuberculous infection, nor does it appreciably increase the calcium content of blood and tissue, and no specific significance has been proved as yet for calcium and its combinations.

Concerning gold therapy, Møllgaard in 1924 presented 'Sanocrysin' ($Au(S_2O_3)_2Na_3$) as a *magna sterilisans* in tuberculosis on the basis of animal experiments. He claimed that 'Sanocrysin' in the blood stream causes lysis and kills the bacilli. Afterwards that substance and several other gold compounds were studied by many workers, who claim that gold exerts no direct bactericidal action on the tubercule bacillus, but that it increases the resistance through the reticulo-endothelial cells. According to them, gold appears to have found its place as a reinforcing stimulant in the therapy of tuberculosis, especially in cases in which collapse therapy is for some reason or other impossible.

The year 1935 brought a great change in bacterial chemotherapy by the discovery of sulpha drugs. After the first reports of Rich and Follis[2] on the inhibitory effect of sulphanilamide in experimental tuberculosis of guinea pigs, two opposing opinions developed concerning this effect: first, that of the group of investigators who used exactly the same technique as Rich and Follis and obtained similar results, especially with sulphanilamide and sulphapyridine; secondly, that of the group of investigators who chose other routes of administration and also different sulphonamide derivatives; but the drugs tested were comparatively ineffective.

Striking results have been attained by Feldman and Hinshaw[3] and their co-workers in experimental tuberculosis of guinea pigs treated with the new diaminodiphenylsulphone compound 'Promin'. 'Promin', in its solid form, varies from white to light yellow and

is slightly hygroscopic. It is highly soluble in water, and 40 per cent solutions are stable indefinitely and can be sterilized by heat. It is slightly bitter, but small amounts may be mixed with the food of animals without impairing their appetite or digestion. The guinea pigs tolerate a daily dosage by mouth of 300–400 mgm. over long periods. The experiments indicated that in many of the animals 'Promin' either had prevented the establishment of lesions or had caused their eventual disappearance. In the vast majority of the animals in the treated group that had lesions, the histopathological characteristics of the disease process apparently were modified favourably. The failure to demonstrate lesions of tuberculosis in a considerable number of the animals that were treated, and the further fact that the disease in the treated animals was with few exceptions minimal and non-progressive, indicate that the action of the drug was significant. Encouraged by the animal experiments, 'Promin' has been used in the treatment of a few cases of tuberculosis in human beings. In man, unfortunately, much lower dosage relative to weight may soon produce toxic effects, particularly hæmolytic anæmia. In these few cases treated with 'Promin', it appeared that outstanding success has not been attained in man with any dosage which is well tolerated. In Great Britain, Tytler and Lapp[4] applied 'Promin' locally to superficial tuberculosis lesions in ten cases. The improvement in all cases was greater, or more rapid, than would have been expected by orthodox methods of treatment. These authors reported that Dr. G. T. Allerton, of Torquay, had been applying the drug to superficial lesions with much success.

In 1943, Kharash and Reinmuth reported on a derivative of N-(1-carboxyacylaminoethylthiomethyl) designated as 'Kharash 1048'. This substance had shown an inhibitor effect on the development of experimental tuberculosis in guinea pigs (Hinshaw and Feldman[5]). More recently, Petter and Prenzlau[6] have described their results with diazone (the disodium formaldehyde sulpho oxylate derivative of 4-4″ diaminodiphenylsulphone, a compound synthesized by Raiziss) in forty-four patients. All the patients received diazone for 120 days or more. The total daily dose was 1 gm. There appear to have been no serious reactions except some cyanosis and nausea in about one quarter of the patients. Signs of improvement were first noticed between the 45th and 125th days of treatment. In 60 per cent of the group, sputum became negative. The authors consider they observed marked improvement in 18 per cent and moderate improvement in 50 per cent of cases.

Thus 'Promin', diazone and other related compounds appear to possess in varying degree the striking power of restraining the development of experimental tuberculosis in guinea pigs; but it is recognized that experimentally induced tuberculosis in guinea pigs offers many contrasts with clinical tuberculosis in human beings, even though the causative organism is the same. Despite the lack of convincing evidence of the value of present chemotherapeutic substances in the treatment of human tuberculosis, further controlled clinical investigation is clearly desirable.

No review of progress in this sphere would be complete without reference to the observations made on antibiotic substances produced by micro-organisms such as penicillin, gramicidin, etc. The treatment with antagonistic organisms was initiated by Cantani (1885), who employed, with reportedly favourable results, an organism designated as 'Bacterium Termo'. Later, many papers on that subject were published announcing varying degrees of success. Recently, two papers appeared on the subject, one by the present writer[7], who obtained promising results *in vitro* with filtrate of culture of *Aspergillus Fumigatus* No. 367 N.C.T.C., grown on modified Czapek Dox medium, and a second published by Miller and Rekate[8], who found that the growth of a strain of the tubercle bacillus was inhibited by a green mould of the penicillin group which accidentally grew on a culture of the tubercle bacillus stored in an icebox. The negative effect of penicillin upon *Mycobacterium tuberculosis* has been reported by Sir Howard Florey and his school[9].

All possibilities for the treatment of the disease should be explored at the present time, when the number of clinical cases of tuberculosis is increasing daily in starving Europe. Even in Great Britain, where conditions of living are fairly good, Stocks[10] considers that for all forms of tuberculosis the cost of the War up to mid-1942 may be estimated at about 11,000 deaths. Research on the control and treatment of tuberculosis should be regarded as a matter of urgency at the present time, and it is difficult to understand why there has been no foundation of a separate institute for the study of tuberculosis.

However, as research continues and newer compounds are made available, what were perhaps previously considered to be futile efforts now assume a new importance and provide a measure of hope for believing that an effective chemotherapeutic agent will be eventually found.

[1] *Amer. Rev. Tuberc.*, **7**, 1 (1923).
[2] *Bull. Johns Hopkins Hosp.*, **62**, 77 (1938).
[3] *Amer. Rev. Tuberc.*, **41**, 732 (1940).
[4] *Brit. Med. J.*, **2**, 750 (1942).
[5] *Amer. Rev. Tuberc.*, **50**, 202 (1944).
[6] *Amer. Rev. Tuberc.*, **49**, 308 (1944).
[7] *Nature*, **154**, 550 (1944).
[8] *Science*, **100**, 172 (1944).
[9] Abraham *et al.*, *Lancet*, 251, 171 (1941).
[10] *Brit. Med. J.*, **2**, 750 (1942).

SOUTH-EASTERN UNION OF SCIENTIFIC SOCIETIES

ANNUAL CONGRESS, 1945

THE fiftieth annual congress of the Union was held at Harpenden on July 7 at the invitation of the director of Rothamsted Experimental Station and by arrangement with the Harpenden Urban District Council. Before the presidential address was given the following sectional addresses were delivered: "Church Chests", by Edward Yates; "Trace Elements", by Dr. Winifred E. Brenchley; "Some New Weapons in the Geological Armoury", by P. Evans; "Country Planning", by C. S. Orwin; and "Fishing Research and the Overfishing Problem", by Dr. E. S. Russell.

Before the official business of the Union was transacted, Miss E. C. Busby, chairman of the Urban District Council, welcomed the congress. The new president, Dr. W. G. Ogg, director of Rothamsted Experimental Station, was then installed and gave an address entitled "Some Aspects of the Work at Rothamsted". Brigadier F. A. E. Crew presided. The presidential and sectional addresses will be pub-

lished in full in Vol. 50, 1945, of the *South-Eastern Naturalist and Antiquary*.

Dr. Ogg mentioned that the Rothamsted work can be divided into two broad sections, one on soils and plant nutrition and the other on plant pathology and insect pests. Field experiments still occupy a prominent place in the programme. An important but little-known branch of this work is formed by the experiments conducted on farmers' own land in various parts of Britain; these provide information about the efficiency of fertilizers over a wide range of soil types and climatic conditions. Although field experimentation of this kind is done extensively in certain other countries, much of it is not above the 'demonstration' level. The number of the Rothamsted 'outside' experiments, the length of time they have been in progress and the fact that modern statistical technique is used, make them a unique series.

Modern experimental technique in conjunction with tests of the validity and significance of results was developed at Rothamsted as a corpus of knowledge by Prof. R. A. Fisher. It is used in all laboratory and field work at Rothamsted, and though barely twenty years old is standard in agricultural experimentation throughout the Empire, and is being increasingly adopted by progressive countries elsewhere. Efficient sampling surveys are a recent development of this technique and have been applied to various war-time activities, notably the formulation of a fertilizer policy. Philosophically, the new technique is of interest because it enables several factors to be examined simultaneously; as Fisher pointed out, if Nature were asked only one question she would often refuse to answer until some other topic was discussed.

A broad base is characteristic of the Rothamsted work; for example, biology cannot be excluded even from the study of soil physics. The availability of soil moisture for plants is bound up with organic manuring, including the use of leys; and cultivation cannot be studied without reference to roots. Fundamental work has been done at Rothamsted on the relation of the nodule bacteria to their host plants, and, with an increased staff, microbiological studies are being extended to include mycorrhiza and other problems having a community interest in more senses than one. From their very nature, the botanical studies on weeds in arable and grass-land have long had this interest.

The pathological studies include the intricate relationships between viruses and their insect vectors, and the not less obscure problems of the relation between husbandry and fungal diseases. The population aspect of insect behaviour has been a feature of the entomological work. The study of pest outbreaks is regarded as an appreciation of the changes in insect numbers in a locality. A distributional outlook has recently been brought to bear on problems of slugs and earthworms.

Collaboration between chemist and biologist in the department dealing with insecticides has brought about some remarkable achievements, including the establishment of an 'insect zoo', by means of which healthy insects for testing purposes are on hand the greater part of the year. In conclusion, Dr. Ogg said he would like to mention his hopes for the Department of Pedology now being formed. Soil classification is still in its infancy; in particular, the understanding of tropical soils is far from satisfactory. In the new department attention will be given to Colonial as well as to domestic soils. In this department, as in others, while preserving the best in the old we must have an adventurous outlook on the new.

In July 1946 the Union hopes to hold its jubilee congress of three or five days at Tunbridge Wells, the president-elect being Dr. Lancelot Hogben.

CARNEGIE CORPORATION OF NEW YORK

THE annual report of the Carnegie Corporation of New York for 1944 includes the report of the president, W. A. Jessup, prepared before his death on July 9, 1944, and the report of the secretary and of the treasurer. The report of the president for the year ending September 30, 1944, compares the work of the Corporation and the college thirty years ago and now, and stresses the extent to which American colleges and universities have, with their responsibility for large endowments, found themselves engaged indirectly or directly in many forms of business; the ownership and control by the University of Chicago of the "Encyclopædia Britannica" and of the educational films of Eastman Kodak Co. and Electrical Research Products Inc. being an example. One leading mid-western university has reported contracts with Government agencies alone which involve the expenditure of more money than the university proper has ever before expended in a single year.

The U.S. Government, through its Office of Scientific Research and Development, is currently expending more than 125,000,000 dollars in research carried on chiefly by university scientific men. In recent years it has been a common practice for business and industrial organizations to unite in establishing foundations to enable them to work more effectively with the colleges and universities. A distinctive feature of these relations of the college and the university to the public is the fact that Government, industry, private donors and foundations tend to specify the purpose for which the money is to be expended. This tendency to delimit the use of money is so common that only the exceptional college president or trustee can discuss the future of his institution in terms other than those of itemized additions to its programme. The combined endowments of colleges and universities to-day, as reported to the U.S.A. Office of Education, are more than 1,686,000,000 dollars, as compared with the 166,000,000 dollars at the turn of the century. At the present time the income of the Carnegie Corporation is about 4,500,000 dollars, while the receipts of American colleges in 1940 exceeded 630,000,000 dollars. Comparatively, the educational importance of the Corporation, as expressed in income and assets, is thus less than a generation ago. The reduction in income of the Corporation and the consequent reduction in grants made places a heavy burden on the trustees in appropriating the available income, and an examination of the list of appropriations during 1930–32 shows many grants for purposes which are no longer largely aided by the Corporation.

The report of the secretary contains a complete list of appropriations voted during the year 1944 totalling 5,873,215 dollars, the largest single grant being 5,000,000 dollars to increase the endowment of the Carnegie Institution of Washington, making that Institution the most heavily endowed scientific research agency in the United States, if not in the world. Its total endowment is now some 32,000,000

dollars. In addition to grants to various national emergency organizations, the Corporation voted 75,000 dollars to the Carnegie Endowment for International Peace for its educational work in the United States, 40,000 dollars to the Council of Foreign Relations for its research and publication programme and programme of regional committees, 34,000 dollars to the Institute of Pacific Relations and 10,000 dollars to the Foreign Policy Association.

The most ambitious single Corporation project concerning the Negro has been the comprehensive study of the Negro in America conducted by a staff of research specialists directed by Dr. Gunnar Myrdal, which was published in two volumes in January 1944 under the title "An American Dilemma: The Negro Problem and Modern Democracy". The Corporation is endeavouring to regain and maintain flexibility of action from year to year in regard to the use of annual income, and the trustees are studying carefully what particular interests in the crucial times to come may best constitute an effective programme for the Corporation. The report of the secretary also includes a list of useful publications with the issue of which the Corporation has been concerned.

THE COD

AN important and detailed account of the biology and economy of the cod in the Newfoundland area has now become available*, based mainly on tagging experiments during 1931–35, both in inshore and in deep waters. The fishing industry in these regions has tended to lag behind those of other countries, not on account of lack of fish but because of the geographical position of Newfoundland, its small population and the absence of international trading facilities. With Norway and Iceland it is one of the three great centres of cod stocks, and it has also many other valuable fish.

The vast area of Grand Bank is the outstanding important portion of the Newfoundland area and is the key area for study. It should probably be regarded as containing the parent cod stocks with which many subsidiary stocks, including those found inshore, must be correlated. The study of the inshore cod should therefore on no account be separated from that of the cod on the banks, especially Grand Bank, and the deep-sea fishing should certainly be increased and not reduced, as the reservoir of fishes is on the banks. It is essential that both the inshore and bank fisheries should be intensively developed.

Reference for comparison is made to previous tagging experiments in the north-western Atlantic, Greenland and Iceland, the Faroe Channel and the north-eastern Atlantic. From these it appears that the cod (especially young cod) are comparatively circumscribed in their movements, the larger proportion of recaptures being made in or near the point of tagging. A few carry on extended migrations, and for spawning purposes there can be what amounts to mass migration from one region to another, the migration being necessary probably where good feeding and spawning conditions do not occur in the same region. The evidence supports the general hypothesis of the existence of local races of cod, most of which, in any event in the early years of life, remain within a region where a specific range of hydrographic and feeding conditions prevails, and in these there are characteristic and recognizable biological features, such as average number of vertebræ, rate of growth and fluctuations in good, moderate and poor years of hatching and survival of fry.

With regard to the Newfoundland tagging experiments, the main object of which was to obtain direct evidence of migrations, it was found that those tagged on the banks were much larger than those tagged elsewhere, the latter being mostly immature fish; 91·2 per cent of the inshore cod tagged were recaptured locally within 100 miles (and more than half of these within 10 miles), and only 8·8 per cent travelled distances of upwards of 100 miles. Only 1·5 per cent travelled more than 250 miles, a distance which might or might not take the cod into a zone of markedly different hydrographical conditions. With the bank cod the results were somewhat similar, but only 68·9 per cent were recaptured within 100 miles, and 31·1 per cent carried out migrations of more than 100 miles. Only 6·8 per cent exceeded 250 miles. Thus the bank cod carried on rather more extensive migrations than those from the inshore.

The fish up to about three years old are practically stationary, and up to the age of six or seven years, or even more, the average movement from the location would probably not exceed 200 miles. Thus there is every reason to believe that races of cod can occur. After maturity is reached, there appear to be increased migrations and intermingling. The maximum distance travelled by any recaptured cod was 560 miles, from Fortune, in the south of Newfoundland, to White Bay, in the north-east.

From the analysis of results of counts of vertebræ, and of first-year circuli in the fish scale, it is possible to recognize two main stocks: those growing to maturity in cold water (arctic type) and those in warmer ocean water (bank type) respectively. Mixing of these also takes place to a certain extent. The parent stock is probably that of the Grand Bank.

The majority of Newfoundland cod attain first maturity between the sixth and ninth year of life, at a size of 60–80 cm. In this they resemble Iceland and Norwegian cod rather than those from the North Sea, where maturity occurs at an earlier age than the above. Most spawning occurs in spring, but the season may extend from March to October. It is later in the north than in the south. The distribution of eggs and fry varies according to the type of season—whether or not the arctic current is of normal, or of greater or less than normal strength. Eggs and fry occur chiefly off the east coast of Labrador and Newfoundland and on the banks, the centre of density of distribution being rather more northerly in warmer years, and more southerly in colder years.

The fishery in general is most successful in colder rather than warmer years, although cod in more southerly regions are conditioned to water of higher temperatures than are cod of more northerly regions. In the latter, large catches are made in water of temperature 0° C. and even lower. The optimum temperature for large catches varies according to the region. It would be of advantage if information on prevailing and probable temperature conditions were made available to fishermen.

There is no sign of overfishing on the Grand Bank, which is probably capable of producing a higher yield. It is through the moderate development of trawling that progress is likely to be made.

* Newfoundland Gov. Research Bull. No. 14: A Biological and Economic Study of the Cod (*Gadus callarias* L.) in the Newfoundland Area including Labrador. By Dr. Harold Thompson. Pp. 160. (St. John's: Department of Natural Resources, 1943.)

APPOINTMENTS VACANT

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

ENGINEER AND MANAGER OF THE WARRINGTON WATER UNDERTAKING—The Town Clerk, Town Hall, Warrington (endorsed 'Water Engineer and Manager') (August 24).

SENIOR ENGINEERS (capable of designing high or low pressure water turbines, governors, or hydraulic valves) for work in the Midlands—The Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 670, York House, Kingsway, London, W.C.2, quoting D.1139.X (August 24).

CIVIL ENGINEERING ASSISTANT, and JUNIOR ENGINEERING ASSISTANTS (3, temporary)—The Clerk to the River Ouse Catchment Board, 7 Landcliffe Avenue, Harrogate (August 25).

DEPUTY CHIEF DRAINAGE AND WATER SUPPLIES OFFICER—The Executive Officer, Cheshire War Agricultural Executive Committee, Reaseheath, Nantwich (August 25).

SPEECH THERAPIST to the West Ham Education Committee—The Education Officer, Education Offices, 95 The Grove, Stratford, London, E.15 (August 25).

RESEARCH ASSISTANT AND DEMONSTRATOR IN ZOOLOGY—The Acting Registrar, The University, Leeds (August 25).

LECTURER IN BOTANY—The Registrar, The University, Manchester, 13 (August 25).

ADVISORY BACTERIOLOGIST for the East Midland Province—The Principal, Midland Agricultural College, Sutton Bonington, Loughborough (August 25).

TECHNICAL ASSISTANT in the Borough Engineer's Department—The Borough Engineer and Surveyor, Hornsey Town Hall, Crouch End, Broadway, London, N.8, endorsed 'Technical Assistant' (August 27).

ASSISTANT LECTURER (temporary) IN GEOGRAPHY—The Registrar, University College, Singleton Park, Swansea (August 28).

HEAD OF THE TECHNOLOGICAL AND SCIENCE DEPARTMENT of the Wakefield Technical College—The Director of Education, Education Department, 27 King Street, Wakefield (August 29).

LIBRARIAN, at the College in Trinidad—The Secretary, Imperial College of Tropical Agriculture, Grand Buildings, Trafalgar Square, London, W.C.2 (August 31).

MECHANICAL ENGINEERS for oil refineries (Ref. No. C.2587.XA), SENIOR RESEARCH ENGINEERS (Ref. No. C.2622.XA), and SENIOR MECHANICAL ENGINEERS for direction of work on the application of fuels and lubricants to i/c and other engines, and to various types of industrial work (Ref. No. C.2667.XA), for home and overseas service with a large industrial organization—The Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 670, York House, Kingsway, London, W.C.2, quoting the appropriate Reference No. (August 31).

GAS ENGINEER AND MANAGER—The Town Clerk, Town Hall, Southport, endorsed 'Gas Engineer and Manager' (August 31).

STRATHCONA-FORDYCE CHAIR OF AGRICULTURE—The Secretary, The University, Aberdeen (August 31).

PSYCHOLOGIST (full-time)—The Chief Education Officer, County Hall, Taunton (September 1).

PSYCHIATRIC SOCIAL WORKERS (2, full-time, women) for Ealing and Harrow—The Clerk to the County Council, Middlesex Guildhall, Westminster, London, S.W.1 (September 1).

LECTURER IN PHYSICS—The Registrar, King's College, Newcastle-upon-Tyne (September 3).

PRINCIPAL OF SUPERINTENDING METALLURGIST with headquarters in London, a SENIOR OF PRINCIPAL SCIENTIFIC OFFICER (preferably a physical chemist) for refractories, moulding sands, slags, etc., a SENIOR OF PRINCIPAL SCIENTIFIC OFFICER (preferably a physicist) for instruments and automatic control in all fields of the Iron and Steel industry ; and other posts of a more junior category for Chemists, Physicists, Engineers and Metallurgists—The Secretary, British Iron and Steel Research Association, Steel House, Tothill Street, London, S.W.1 (September 7).

PROBATIONARY ASSISTANT LECTURER IN PHYSICS, a PROBATIONARY ASSISTANT LECTURER IN CHEMISTRY, and a PROBATIONARY ASSISTANT LECTURER IN ZOOLOGY—The Bursar and Acting Registrar, University College of North Wales, Bangor (September 10).

PROBATIONARY ASSISTANT LECTURER IN AGRICULTURAL BOTANY—The Bursar and Acting Registrar, University College of North Wales, Bangor (September 10).

CIVIL ENGINEER OF PUBLIC WORKS CONTRACTOR'S AGENT to take control of an area in connexion with the employment of German P.o.W. labour on construction of roads and sewers (Ref. No. E.1645.A), an ASSISTANT CIVIL ENGINEER OF ARCHITECT A.M.I.C.E. or A.M.I.M. and Cy.E. or A.R.I.B.A., or equivalent, to act as assistant to the above (Ref. No. E.1735.A), and a CIVIL ENGINEERING (Structural) ASSISTANT (Ref. No. E.1462.A)—The Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 670, York House, Kingsway, London, W.C.2, quoting the appropriate Reference No. (September 14).

ACADEMIC REGISTRAR—The Principal, University of London, Richmond College, Richmond, Surrey (September 15).

CHIEF ASSISTANT (male) AT THE GOVERNMENT ARCHIVES, Salisbury, Southern Rhodesia—The Official Secretary to the High Commissioner, Rhodesia House, 429 Strand, London, W.C.2 (September 17).

LECTURER IN NATURAL PHILOSOPHY at University College, Dundee—The Secretary, The University, St. Andrews (October 1).

UNIVERSITY CHAIR OF ANATOMY, tenable at St. Bartholomew's Hospital Medical College—The Academic Registrar, University of London, Richmond College, Richmond, Surrey (October 31).

LECTURER IN APPLIED MATHEMATICS within the Department of Natural Philosophy—The Secretary, The University, Aberdeen.

LENS WORKSHOP INSTRUCTOR (full-time)—The Principal, Northampton Polytechnic, St. John Street, London, E.C.1.

SUPERINTENDENT OF APPLIED RESEARCH—The Secretary, British Rubber Producers' Research Association, 19 Fenchurch Street, London, E.C.3.

CHAIR OF NAVAL ARCHITECTURE in the Faculty of Engineering of the Technical University, Istanbul—The Appointments Department, British Council, 3 Hanover Street, London, W.1.

BIOLOGY MASTER to teach the Zoology of the Science Sixth Form, to Open Scholarship standard and General Biology throughout the School—The Headmaster, Blundell's School, Tiverton, Devon.

ASSISTANT TO CHIEF CHEMIST—The Establishment Officer, Milk Marketing Board, Thames Ditton, Surrey.

TECHNICAL ASSISTANT TO THE ADVISORY BACTERIOLOGIST, in connexion with the National Milk Testing and Advisory Scheme. Southern Province—The Advisory Dairy Bacteriologist, National Institute for Research in Dairying, Shinfield, Reading.

LECTURER (full-time) IN THE APPLIED CHEMISTRY DEPARTMENT—The Secretary, Northampton Polytechnic, St. John Street, London, E.C.1.

PSYCHOLOGISTS (part-time) for Child Guidance Clinics—The Chairman, Child Guidance Committee, County Hall, Chichester.

LECTURER IN ENGINEERING (subjects : Practical Mathematics and Engineering Science up to Ordinary National Certificate standard)—The Principal, Day Continuation and Technical Schools, Falmouth.

ASSISTANT (temporary, full-time) with First or Second Class Honours or Higher Degree in Mathematics, at the Bridgend Mining and Technical Institute and Technical School—The Director of Education, County Hall, Cardiff.

TEACHER FOR ENGINEERING SUBJECTS, chiefly in the Day Junior Technical School—The Principal and Secretary, Harris Institute, Preston.

LECTURER (man or woman) IN MATHEMATICS AND PHYSICS at the Dudley Training College—The Secretary to the College Council, Education Offices, St. James's Road, Dudley.

SENIOR MATHEMATICS MISTRESS to organize the subject throughout the School to University Entrance standard, and an ASSISTANT MISTRESS to teach PHYSICS or BIOLOGY, and MATHEMATICS—The Headmistress, The Abbey, Malvern Wells, Worcs.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Bath and West and Southern Counties Society. Pamphlet No. 13 : Fertilizers during the War and After. By Dr. E. M. Crowther. Pp. xiv+54. (Bath : Bath and West and Southern Counties Society, 1945.) 2*s*. [197

The New Education Act : a Talk to Parents. Pp. 8. (London : National Union of Teachers, 1945.) Free. [207

University of London. Report of the Principal on the Work of the University during the Year 1944-45. Pp. 8. (London : University of London, 1945.) [207

Other Countries

National Research Council of Canada. The Distribution of Thunderstorms and the Frequency of Lightning Flashes : a Review. By R. Ruedy. (N.R.C. No. 1282.) Second edition, revised and enlarged. Pp. 70+5 plates. (Ottawa : National Research Council of Canada, 1945.) 1 dollar. [27

Indian Central Jute Committee. Technological Research Memoir No. 6 : The Relations between the Chemical Fibre Characters and the Spinning Quality of Jute. By P. B. Sarkar, S. B. Bandyopadhyay and C. R. Nodder. Pp. 16. (Calcutta : Indian Central Jute Committee, 1944.) 12 rupees ; 1*s*. [27

Imperial College of Tropical Agriculture. Report of the Governing Body and the Principal's Report to December 31st, 1944, and the Accounts for the Year ended August 31st, 1944. Pp. 28. (Trinidad and London : Imperial College of Tropical Agriculture, 1945.) [37

Tata Memorial Hospital for the Treatment of Cancer and Allied Diseases. First Triennial Report, 1941-1943. Pp. vi+36. (Bombay : Tata Memorial Hospital, 1945.) [37

Indian Forest Leaflet. No. 66 : Indian Woods for Pencil Making. By M. A. Rehman and S. M. Ishaq. Pp. ii+8. (Dehra Dun : Forest Research Institute, 1945.) 4 annas. [37

Indian Forest Records (New Series). Utilization, Vol. 3, No. 6 : The Identification of Burma Commercial Timbers. By Dr. K. Ahmad Chowdhury. Pp. iii+27+15 plates. (Dehra Dun : Forest Research Institute, 1945.) 12 annas. [37

Survey of India. Geodetic Report, 1940. Pp. iv+34+9 charts. (Dehra Dun : Survey of India, 1945.) 2 rupees ; 3*s*. [37

Zoological Society of Egypt. Supplement to Bulletin No. 7 : A Collection of Birds from Western Saudi-Arabia, January to June 1944. By Shamseddin Halfawi. Pp. 12. (Cairo : Zoological Society of Egypt, 1945.) [47

Parliament of the Commonwealth of Australia. Eighteenth Annual Report of the Council for Scientific and Industrial Research, for the Year ended 30th June 1944. Pp. 78. (Canberra : Government Printer, 1945.) 3*s*. 4*d*. [57

Report and Accounts of the National Botanic Gardens of South Africa, Kirstenbosch, Newlands, Cape (and the Karoo Garden, Whitehill, near Matjesfontein) for the Year ending 31st December 1944. Pp. 14. (Kirstenbosch : National Botanic Gardens, 1945.) [97

Archivos de la Clínica Médica del Prof. Dr. Juan Carlos Plá. Tomo 2 : 1942 y 1943. Pp. 612. (Montevideo : Hospital Pasteur, 1944.) [127

Geological Survey of British Guiana. Bulletin No. 20 : Report on Exploration for Oil in British Guiana. By H. G. Kugler, S. C. Mackenzie, R. M. Stainforth, J. C. Griffiths and G. R. Brotherhood. Pp. 78+6 plates. (Georgetown : Government Printers, 1944.) 1 dollar. [177

League of Nations : Fiscal Committee. Model Bilateral Conventions for the Prevention of International Double Taxation and Fiscal Evasion. Second Regional Tax Conference, Mexico, D.F., July 1943. (Official No. : C.2.M.2.1945.II.A.) Pp. 88. (Geneva : League of Nations ; London : George Allen and Unwin, Ltd., 1945.) 3*s*. 6*d*. [177

South Australia : Department of Mines, Geological Survey of South Australia. Bulletin No. 22 : The Search for Oil in South Australia. By Dr. L. Keith Ward. Pp. 40. (Adelaide : Government Printer, 1944.) [177

Printed in Great Britain by FISHER, KNIGHT & CO., LTD., The Gainsborough Press, St. Albans, and published by MACMILLAN & CO., LIMITED, at St. Martin's Street, London, W.C.2, and THE MACMILLAN CO., 60 Fifth Avenue, New York 11, N.Y., U.S.A.—Saturday, August 18, 1945