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CONTENTS

	Page
British Empire Scientific Conference	373
A Physicist Looks at Genetics. By Prof. J. B. S. Haldane, F.R.S.	375
Psychology or Religion? By H. J. Jacoby	376
Broadcasts on Farming	377
Hydraulics in Theory and Practice. By Dr. J. B. Todd	377
Artificial Production of Coat Colour in the Albino Rat: its Relation to Pattern in the Growth of Hair. By Dr. Alexander Haddow, Dr. L. A. Elson, Dr. Edna M. F. Roe, Dr. K. M. Rudall and G. M. Timmis	379
Dormancy in British-grown Wheat. By E. N. Greer and J. B. Hutchinson	381
University Reform in Britain. By Dr. Raymond Priestley	383
New Fellows of the Royal Society	384
News and Views	385
Letters to the Editors:	
Age of the South African Ape-men.—Dr. R. Broom, F.R.S.	389
Index of Diversity as Applied to Ecological Problems.—E. W. Jones; Dr. C. B. Williams	390
Colour Vision of the Fovea Centralis.—Prof. H. Hartridge, F.R.S.	391
Nutritive Value of Coconut.—Dr. Lucius Nicholls; Sir Jack Drummond, F.R.S.	392
Linoleic Acid, α -Tocopherol and other Fat-Soluble Substances as Nutritional Factors for Insects.—Dr. G. Fraenkel and M. Blewett	392
Acaricidal Property of a New Insecticide, Hexachlorobenzene.—E. L. Taylor	393
'D.D.T.' as a Sheep Blowfly Dip.—J. B. Cragg	394
Hydrogen Sulphide Gas as a Preventive of Putrefaction.—Madge E. Robertson	395
Vernalization of Rice by Short Days.—Dr. S. M. Sircar and B. Parija	395
Two New Records of <i>Sphacelia</i> from Mysore.—Dr. M. J. Thirumalachar	395
Scattering of Light in Crystals.—Sir C. V. Raman, F.R.S.	396
X-Ray Crystallography of Kojic Acid.—A. H. Fox Long	397
Duration of the Balmer Spectrum in Excited Hydrogen.—Dr. A. Jabłoński	397
Vibration in Telegraph Wires.—D. Barron Cruickshank and B. Falkner Lewis	397
Effect of Substituents on the Oxidation Potential of Ferrous <i>ortho</i> -Phenanthroline Complexes.—R. V. G. Ewens	398
Causality or Indeterminism?—Lord Brabazon of Tara	398
Research Items	399
Oxidation-Reduction Aspects of Resazurin. By the late R. S. Twigg	401
Industry and University Education	402
Mode of Action of Penicillin. By Dr. G. Lapage	403
Indian Forest Yield Tables	404
Adsorption of Water by Proteins	405
Effect of Mulching on the Soil	405
Recent Scientific and Technical Books	Supp. ii

BRITISH EMPIRE SCIENTIFIC CONFERENCE

THE address on "Scientific Co-operation within the British Commonwealth" which Prof. A. V. Hill delivered to the Royal Empire Society on January 31 has claims on the close attention of all scientific workers. In the first place, it gives an account of the actual progress that has been made in implementing co-operation since the committee appointed by the Royal Society reported in 1943. In particular, the Empire Scientific Conference to be called in London by the Royal Society either later this year or, more probably, in 1946, which is one indirect result, not merely of that report, but also of Prof. A. V. Hill's visit to India, of the more recent visit of Indian men of science to Britain and of Sir Henry Tizard's visit to Australia and Canada in 1943, will call for the active support of many more scientific workers than the sixty actual delegates contemplated.

Prof. Hill said that the Conference will probably be held in two parts, the first and more purely scientific gathering being followed by a more official conference for working out concrete plans for submission to the Governments concerned. During the interval, the visitors will travel about Britain in small groups, to see British science, industry, agriculture and medicine in operation, and above all to gain by informal discussion personal acquaintance with each other's problems, programmes and ideas. The value of this informal contact is rightly stressed by Prof. Hill, as in the British Commonwealth Science Committee's report, where it formed the subject of two of the six main recommendations; such contacts are in fact one of the most important things to implement. No organization, as we have urged repeatedly, can be an effective substitute for that full freedom of intercourse and communication, both spoken and written, which for more than five years has been severely limited by war conditions.

If it is true and right that such fundamental freedom should be restored first within the British Commonwealth and as early as possible, it is true also that these proposals to improve and extend imperial co-operation in science are also important in relation to the wider field of scientific co-operation generally, to which Dr. Joseph Needham directed attention in his plea for an international science co-operation service as a functional body parallel with the International Labour Organisation and the Food and Agricultural Office, and on which Sir Henry Dale dwelt at some length in his anniversary address to the Royal Society on November 30. Prof. Hill also emphasizes the importance for international scientific co-operation of such developments in scientific co-operation within the British Empire, and one of his reasons for urging British leadership in this field is the vital importance of building up as rapidly as possible a world organization for sharing the beneficent results of scientific discovery. Above all, it might be fittingly urged at the present time that it is essential to re-establish as early and as fully as

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possible those contacts in science which will revive in the harassed peoples of Western Europe the sense of common traditions and heritage in science no less than in law and government, in humanism and in Christianity, with all that such a revival can mean to them as they address themselves to the reconstruction of their national life.

While that appears to be the setting in which Prof. Hill rightly views proposals for imperial co-operation in science, the practical tone of his address is unmistakable. His visit to India has convinced him that the best hope of friendly co-operation between India and Britain lies in the scientific, technical and medical fields. It is now probable that the Government of India will set up an Indian Scientific Office in London, and an Indian Scientific Liaison Service may be established with its headquarters in Delhi, its main overseas office in London, and branches in other countries.

Other promising developments are also noted by Prof. Hill, such as the work of the Colonial Research Committee and of the Colonial Products Research Council, and closer contact and co-operation between these bodies and the Dominions and India could scarcely fail to be of mutual advantage in dealing with many scientific, technical, agricultural or medical problems. Again, the attachment of two able scientific advisers to the Middle East Supply Centre is of special interest. In the region covered by the Middle East Supply Centre, science, particularly the biological sciences, could play a dominant part in determining the welfare of the peoples and their relations to the outside world. Problems are encountered in agriculture, irrigation and soil survey, in land conservation and erosion, in geology, meteorology and water supply, in forestry and the preservation or utilization of flora and fauna, in health and nutrition and the like, which are closely analogous to those encountered in other parts of the British Empire; and, further, neglect of the scientific factors will lead to trouble and difficulties which no political astuteness can curb or avoid.

It is, however, in his references to the specific problems in which scientific co-operation within the British Commonwealth is of practical importance that Prof. Hill's address is of the greatest interest. Here he enforces the point that such co-operation alone can provide the solution to important practical problems, some of which, such as that first mentioned by him, namely, the fear of isolation, which deters first-class teachers and research workers from accepting posts in more distant centres, have been raised in recent reports like those of the Colonial Research Committee. Their effects, and means of overcoming it, are obviously problems not for one colony or dominion alone, but for joint consideration and a common policy.

Similarly, the need for quick and frequent personal contacts between research workers in analogous fields is widely recognized; but almost certainly an imperial policy alone can ensure that air transport will supply such contacts regularly for people who are mostly not well paid and have no great political or industrial standing. Again, regular interchange of personnel

between the scientific staffs of universities, industrial firms and research institutions throughout the Commonwealth must largely wait on the formulation of common arrangements, including an appropriate pension system. Allied to this is the problem of organizing and financing the training of young research workers and the higher grades of technologists and workmen by exchange between countries which have special opportunities to offer.

Another group of problems instanced by Prof. Hill as calling for co-operative attention is the combined study of natural resources and conditions—forests, minerals, land utilization, water-power, plants, animals, pests and diseases, and the application of the principles of lend-lease both to their investigation and the utilization of the new knowledge so gained. Here we touch on the question of regional research. Certain regions form natural units for research and development in particular subjects or groups of subjects, although the regions may fall, as in Africa, under the authority of different Governments. The means of securing co-operation and the sharing of effort and expense in such regions require working out; while again, in attempting a concentrated attack on a key problem, we lack the machinery for deciding on the problem and on the method, the scale and the direction of attack and the means by which the expense is to be shared.

Finally, Prof. Hill refers to the question of science and imperial defence, and faces frankly the fact that scientific workers have been troubled in the past as to secrecy being a cover for inefficiency, and the danger of its breeding fear and suspicion. He insists on the need for critical minds and up-to-date methods, for contact with recent scientific discoveries and industrial technique, and for interchange between scientific workers in Government service, in industry and in the universities throughout the British Empire. The relations between civil and military research need to be worked out critically and with imagination; here it may be noted that three of the nine points of imperial defence which Lord Chatfield pressed in the House of Lords on March 7 as requiring investigation closely concern scientific workers. Two of these questions, whether our statesmen require better opportunities of informing themselves on strategical and technical problems of defence, whether service Ministers, when possible, should serve three or four years in their departments so as to master the technical problems, could well be included in the agenda of the proposed conference. The third question, whether the defence of the Empire and the security of the British people could be removed from party strife, or some other means devised to lessen political differences on the basic problems of defence, might also be considered.

Prof. Hill's address shows clearly that a definite practical programme and not mere generalities can be placed before both sessions of the forthcoming Empire Scientific Conference when it meets. There will be ample scope for critical discussion and imaginative planning; but if the Conference is to result in the bold executive action desired, scientific workers must manifest their interest and support in

no uncertain manner in the months preceding its assembly. The application of the methods of biological science, in its widest sense, to the problems of general welfare, and of physical and engineering science to economic and industrial problems, calls for much effort by the individual scientific worker, and, as Prof. Hill points out, may involve facing political as well as scientific and technical issues. Not everyone who recognizes as desirable that fuller and more effective co-operation among men of science for which Prof. Hill pleads will feel as sanguine as he is that such co-operation in the British Commonwealth will appreciably influence the relations of the world as a whole; but it must help rather than hinder international co-operation generally. That the closer co-operation of scientific workers and fuller and freer contacts between them are important factors in the continued advance of science cannot be denied. They are indeed essential conditions in order that mankind may enjoy those higher standards of health and welfare which science has put within our reach. Prof. Hill's address should stir scientific men to take their part not only in thinking about the technical and scientific aspects of the special problems he has indicated for consideration by the Empire Scientific Conference, but also, and equally important, in educating their fellow-citizens as to what is at stake. They can prepare the way for the measures required to implement such co-operation, and to establish and safeguard that code of common ethical standards which, as Prof. Hill so emphatically urged, will be a safeguard against the abuse of science either in peace or in war.

A PHYSICIST LOOKS AT GENETICS

What is Life?

The Physical Aspect of the Living Cell. By Prof. Erwin Schrödinger. (Based on Lectures delivered under the auspices of the Dublin Institute for Advanced Studies at Trinity College, Dublin, in February 1943.) Pp. viii+91+4 plates. (Cambridge: At the University Press, 1944.) 6s. net.

AS a result of the War, many scientific workers have been too busy with the applications of science to keep up even with the development of their own branch. Schrödinger, as an exile in neutral Eire, has found the leisure to study another, namely, genetics, which he describes as "a new branch of science, easily the most interesting of our days". I wonder if posterity will find crossing-over as interesting as exchange energy, or mutation as atomic transition. However this may be, every geneticist will be interested in Schrödinger's approach to his or her science.

Schrödinger sets out to answer the question "How can the events in space and time which take place within the spatial boundary of a living organism be accounted for by physics and chemistry?". He believes that they can, but not by present-day physics and chemistry. Accepting the view, first, I think, put forward by Koltsoff, that a chromosome is a giant molecule, Schrödinger describes it as an aperiodic crystal. Thus it may be expected to have some of the properties of a crystal, including that of

self-reproduction, and yet to be of so highly complex a structure that it can act as a "code-script" for the development of an organism. He thinks that just because a gene is of molecular dimensions, and there are only one or two genes of a kind per cell, one cannot apply statistical mechanics to the behaviour of genes. This is perhaps not quite certain; for an organic catalyst can, in favourable circumstances, transform more than 100,000 substrate molecules per second. If genes are catalysts of this order of activity, even a single gene requires statistical treatment.

Much of the book is devoted to mutation, and the author not merely accepts Delbrück's account of this process, but also writes that "If the Delbrück picture fails, we would have to give up further attempts". This seems a rash statement from a quantum physicist. The modern 'picture' of an atom is not superficially very like Bohr's picture, for discrete orbits of electrons have been replaced by a continuous probability distribution. Yet Bohr's theory explained so much that it was hard to believe that it would be so greatly modified.

Actually I believe that the Delbrück picture will have to be modified profoundly, for the following reason. Schrödinger (p. 65) states that the single event which produces a mutation "must be an ionization or similar process". Lea and Catcheside, in unpublished work communicated to the Genetical Society, which they very kindly allow me to quote, produce strong evidence that many, if not all, lethal mutations produced by irradiating *Drosophila* spermatozoa are due to chromosome breakage followed by restitution; and in *Tradescantia* they¹ calculate that "at least 17 ionizations must be produced in a chromatid to cause a break". In spite of this they think that the 'target-area' gives the size of the gene correctly. In fact, as so often in quantum mechanics, a simple theory gave fairly correct results, but nevertheless had to be modified.

Again (p. 64), the fact that the mutation-rate of wild-type genes is more enhanced by temperature than that of less-stable mutant genes is neatly explained on quantum-mechanical grounds. But Fabergé and Beale² found that the mutation-rate of a very unstable gene actually fell off at high temperatures. Perhaps there are more things in chromosomes than are dreamt of even in wave mechanics.

I make these criticisms not from any desire to denigrate the book before me, but because many geneticists will read it, and all of them should. And not only geneticists. The physiologist who can assimilate the idea that a living organism feeds on negative entropy will come back to the study of metabolism with a slightly novel set of questions to ask. Nevertheless, a whole series of biological problems are not raised. Many biologists have found it impossible to explain the facts of organic regulation on mechanistic lines. Prof. Schrödinger's views on genetics are so interesting that I hope he will tackle this problem, too, in another book. In a living organism we find a hierarchy, so to say, of normal conditions. A man does his best to keep the partial pressure of carbon dioxide and the concentration of bicarbonate ions in his plasma constant. If he fails in either respect, he will use his lungs, kidneys, or both, to bring their ratio, and therefore his pH, back towards normal. But even pH is less important than an adequate oxygen supply. And so on. A mathematical physicist might be able to find physical analogies, or even explanations, for such facts as these.

A mechanist must either give a mechanistic account of mind, or turn a somersault. In his epilogue, Schrödinger does the latter with very great elegance, and adopts a metaphysical position which is roughly that of Samkara Acharya. There is only one soul; the difference between yours and mine being an illusion. I think that here, too, the history of quantum mechanics suggests that the truth may be somewhere between mechanism and advaita metaphysics. There is no way of distinguishing between the two electrons in a hydrogen molecule; you cannot put a spot of red paint on one of them. This fact makes a difference to their behaviour. Nevertheless there are two electrons, not one. Perhaps the relation between two souls is a little more like that between two electrons than between two tables, and these philosophical problems will be solved, or at least transformed, when our descendants learn to apply to mind the kind of analysis which Schrödinger has applied to matter.

However that may be, the book is one to which one comes back again and again. I have lent it to several genetical colleagues, and the verdict has been uniformly favourable. We may disagree with details, or even with fundamental principles, but we cannot stop reading it before the end. Unfortunately, it contains only 93 pages. There are 93 elements, but 738 isotopes have so far been described. Perhaps we may hope for a book of 738 pages on biology in general. Prof. Schrödinger need not doubt that it will find readers.

J. B. S. HALDANE.

¹ *J. Gen.*, 44, 216 (1942).

² *J. Gen.*, 43, 173 (1942).

PSYCHOLOGY OR RELIGION?

The Lady of the Hare

Being a Study in the Healing Power of Dreams. By Dr. John Layard. Pp. 277. (London: Faber and Faber, Ltd., 1944.) 12s. 6d. net.

THIS volume, which is attractively produced and well illustrated, purports to be the first verbatim account ever published of a dream-analysis on Jungian lines. (Jung's numerous own seminar accounts of dream analyses published in limited number for the use of his students may not have come to the notice of the author.) In Part 1, twelve professional sessions are described in which a number of dreams and so-called visions of a woman patient were discussed. This is followed by a brief theoretical discussion, a summary of the dream process, and a description of the subsequent remarkable development of the patient's mentally defective daughter. Since one dream of the patient contains the figure of a hare which she is meant to kill or sacrifice, Part 2 of the book deals with the mythology of the hare, and the author follows up the hare motive in myths and folklore of India, China, Egypt, Africa, North America, Europe and classical antiquity. In Part 3, more dreams about hares and rabbits are communicated.

As Dr. Layard, the anthropologist, has the well-known informative "Stone Men of Malekula" to his credit, one opens this book by Dr. Layard, the psychologist, with high expectations of finding a full and well-substantiated account of a case-history illustrating the practice of Jung's analytical psychology. The author, however, does not fulfil these expectations, but expounds his own psychotherapeutic technique and healing powers, which bear little

relation to Jung's practice and theory of analytical psychology. The result is a book which will fill the informed student of analytical psychology with dismay and induce the uninformed reader to identify the Jungian method with that of the author, which is a fallacious assumption.

Jung defines the aim of analytical psychology as that of individuation. The author defines it (p. 18) as that of salvation, thereby discarding the scientific phenomenological approach of Jung, identifying psychology with religion and the psychologist with the priest or magician (the patient's: "You are a minister of God", p. 47), in defiance of the teachings of Jung (cf. "The Relations between the Ego and the Unconscious"). Nor is the author following Jungian practice in treating the transference of the "Saviour Archetype" by "disclaiming it on every occasion when it arose" . . . "emphasizing the obvious unsuitability of any such personal projection" (p. 82), for according to Jung (*loc. cit.*) the problem of transference defies rationalizations of this kind. However, most alien to the point of view of analytical psychology, which refrains from making sweeping, scientifically untenable claims and conforms to the standards expected from proper clinical psychological research, are two basic aspects of the account given of dream-analysis which reveal the author's unfamiliarity with, or disregard of, the Jungian practice of dream-analysis.

One is that the author gives the unsuspecting reader the impression—and appears to share it himself—that the twelve interviews described, comprising the discussion of twenty-five dreams and visions and covering a period of about two and a half months, perfected a cure comparable with that attained in the gradual process of growth facilitated by a proper analysis. His insistence on quick results ("The deeper the analysis the quicker the cure", p. 20; "The whole interview had lasted just $\frac{1}{2}$ hour, but it had been enough", p. 36; "As last week, the whole interview lasted less than $\frac{1}{2}$ of an hour", p. 58) betrays the anthropologist's fascination for the magic practices of the medicine man, while his belief in miraculous and spectacular healing reminds one of the claims of faith-healers. The claim that his twelve-interview treatment is representative of Jungian practice shows grave lack of knowledge of the work of Jung and his school.

The other main aspect incompatible with Jungian principles and practice is the victimization of the patient during the sessions, as described. Even granting that the expression "verbatim account" may be an exaggeration and should not be taken literally, there remains the fact that undue prominence is given to the author's intuitions about the dreams and his suggestions to the patient, while the patient's own spontaneous associations are partly not admitted and partly not related. This practice is alien to that expounded by Jung.

Thus the main part of the book gives the reader insight into Dr. Layard's psychotherapeutic technique and powers, but the reader must beware of confusing this, as the author has done, with the technique of Jungian analysis.

In Part 2, when collecting the hare motive as found in mythological material of primitives and the ancients, Dr. Layard, the anthropologist, is at work once more, and this part, though of little import for the case described, forms a work of reference on the hare motive which will be very useful for the student of mythology.

The author would be well advised to write the promised second volume without reference to Jung's analytical psychology; for the reference to Jung is apt to create confusion and do a disservice to Jung, and incidentally to the author himself.

H. J. JACOBY.

BROADCASTS ON FARMING

'Farming Talks'

By W. S. Mansfield. Pp. 119+8 plates. (Worcester: Littlebury and Co., Ltd., n.d.) 7s. 6d. net.

Farming To-day Broadcasts

Vol. 2. A Series of Agricultural Education and Technical Development Broadcast Talks. Pp. 130+12 plates. (Worcester: Littlebury and Co., Ltd., n.d.) 7s. 6d. net.

THESE two groups of farming broadcasts are presented without alteration in form, a procedure which has both advantages and demerits. For those who did not hear the original talk or discussion, the structure, particularly when dialogue, does not make for easy reading and there are occasional difficulties of meaning. Those who have heard most of the broadcasts—and they will probably be the majority of readers—will be able to recapture the atmosphere and enjoy again the accents of the speakers.

Since 1937 Mr. Mansfield has been a regular and notable contributor to B.B.C. broadcasts on farming topics—he takes part in six of the discussions in the second series of 'Farming To-day'. The talks and discussions of this second volume were given in 1943 and the first quarter of 1944, and are arranged chronologically. About half of the 'Farming Talks' were given before the War, and the remainder nearly all in its first two years. The illustrations in both volumes are well reproduced; their function is decorative, having no special reference to textual matter.

War needs have changed the character of these broadcasts. Mr. Mansfield's earlier talks were aimed at a wider audience; though intended for farmers, they were designed also to interest the townsman in the land and its problems. There are discussions—for example, one with Dr. Sanders on high and low farming—but mainly they are straight talks, with at the end perhaps a short dialogue with his farm bailiff or rat-catcher, for illustrative purposes. In these he succeeds very well in catching something of the spirit of the land. Talking, in 1938, on successful farming, he quotes Xenophon to the effect that the difference between those who succeed and those who do not is a difference not of knowledge but of care in management. To the extent of conceding that knowledge, experience, good land and adequate capital are not enough without character—and especially adaptability to changing conditions—Mr. Mansfield agrees.

Great changes have been forced on British agriculture by war needs; after the War there must be a further change, which, whatever else it may be, will not be a reversion to the conditions of 1939. The war-time broadcasts have been educational and propagandist in character, aiming at spreading new ideas, publicizing the results of agricultural research, and generally supplementing the work of the war agricultural committees.

Some of the contributors to "Farming To-day Broadcasts" are farmers, some are specialists. Welsh

hill land improvement, sugar beet, haymaking, care of machinery and composting straw are among the topics of discussion. Not all the talks are concerned with immediate needs; particularly where livestock are involved (because of their low reproductive rate) there must be long-term planning. There has been a great decline in the sheep population of Britain. Four discussions deal with hill sheep, arable and grassland flocks, and disease, and consider probable sources and methods of management in post-war agriculture. Naturally none of the subjects is treated at any great length.

HYDRAULICS IN THEORY AND PRACTICE

A Treatise on Applied Hydraulics

By Prof. Herbert Addison. Third edition, revised and enlarged. Pp. viii+614. (London: Chapman and Hall, Ltd., 1944.) 32s. net.

PROF. ADDISON explains, in his preface, that his aim in writing this book was to present a compact summary of the fundamental principles of hydraulics and the manner in which they are applied, and he expresses the hope that the book will meet the requirements of three classes of readers—the engineer in practice who desires to keep in touch with modern developments in hydraulics, the general student of engineering and the student who wishes to specialize in the subject and who desires a reliable basis for further study. In these aims he has succeeded admirably.

The first part of the book deals with theoretical principles and the second with practical applications, the whole being extremely well illustrated by diagrams and photographs. A striking feature is the arrangement of the subject-matter; thus the numerous worked examples, and problems for solution by the student, are collected together towards the end of the book and reference is made to them when illustration is necessary. Such arrangement has the advantage that the continuity of the text is not interrupted and, in any section, the student may obtain, in the first instance, a clear and concise statement of the engineering aspect of each problem as a background to his study of the theoretical discussion.

The second part of the book introduces a wide range of applications, including the flow of water in pipes, channels and streams, the control of water, viscous flow, hydraulic turbines, pumping machinery, power transmission and hydraulic measurements.

From the method of presentation there is ample evidence not only of Prof. Addison's breadth of knowledge, but also of his experience as a teacher and his appreciation of the problems which confront the teacher and student alike, in dealing with the complexities of a subject in which it is particularly difficult to apply the results of theoretical investigation to the conditions which prevail in practice.

While this is an excellent text-book for the use of students preparing for university and institution examinations, it is much more than that, for it summarizes the results of modern research, is equipped with a comprehensive bibliography of recent publications, and its descriptions and illustrations refer to up-to-date installations. Civil, mechanical and electrical engineers will find it a most complete and informative book of reference on hydraulic engineering.

J. B. TODD.

Your Daily Bread

By Doris Grant. Pp. 94. (London: Faber and Faber, Ltd., 1944.) 4s. 6d. net.

THIS little book covers a lot of ground. Essentially, Miss Grant sets out to prove that white bread—or “murdered bread” as she prefers to call it—is responsible for much of our poor and indifferent health, and she pleads the case for wholemeal bread as the remedy. The book contains much scientific material, and although some of it is not very critical, the case is skilfully presented. It is suggested, for example, that because nicotinic acid helps to create skin beauty, “one of the best and easiest ways of ensuring a flawless complexion is to eat whole-wheat bread”.

A section of the book deals with the place of bread in a balanced diet and gives specimen menus. Miss Grant abhors imported or processed foods of any kind, and she is supported in this by Sir Albert Howard, who contributes a chapter on the importance of fertile soil for the production of best-quality wheat. Sir Albert includes all canned foods, chilled meat and frozen fish with white bread as “murdered foods”, and claims that they are responsible for the poor physique of our urban population. Further, he condemns the use of artificial manures of all kinds. Another chapter reproduces the Cheshire memorandum, a statement by a number of medical practitioners from that county on some general aspects of nutrition including the arguments in favour of wholemeal bread.

The book concludes with a number of recipes for cakes, scones, biscuits, etc., using wholemeal flour. Perhaps the most important recipe is that for the ‘Grant loaf’. A sample was made for the reviewer, strictly according to instructions but using ordinary salt and cane sugar, by a skilled baker. When eaten at tea by a family of four, two preferred it to National bread; however, when two days old, one only was still enthusiastic. It is not easy to break dietary habits.

School Physics

By T. M. Yarwood. Part 2. Pp. x + 438. (London: Macmillan and Co., Ltd., 1945.) 7s. 6d.

THIS book includes all that is required for the various School Certificate examinations. Together with the previous more elementary part, it provides the basis for a sound school course in physics. Good features are the frequent references to the applications of science to everyday life; the inclusion of a chapter on radio; and the numerous problems solved in the text.

In the reviewer’s opinion, however, it is a mistake to cover the whole of physics in two books. The inevitable result is that the presentation is not so attractive as in well-known series of books covering the same ground. Having attempted it, dullness might have been avoided by the lavish use of half-tones, but there are only half a dozen in the 400 pages.

There are a few slips and inadequacies: two may be mentioned. On p. 73 it is said that the gas ejected from a jet-propelled plane “presses on the air behind the aeroplane, and the machine is thus pushed forward”. On p. 131, stress is laid on the thermal capacities of water and mercury, water and sand, etc. The effect of their relative densities should also be mentioned when comparing the thermal capacities of two bodies, for example, two thermometers.

J. P. STEPHENSON.

On a Class of Linear Transformations Connected with Group Representations

By Lars Garding. (Meddelanden från Universitetets Matematiska Seminarium, Band 6.) Pp. 125. (Lund: C. W. K. Gleerup, 1944.) n.p.

BASIC spinors are defined with reference to the equation $T^{-1}\gamma_i T = \sum a_{ij}\gamma_j$, where γ_i represents a set of anti-commuting matrices, $[a_{st}]$ is the matrix of an orthogonal transformation, and T is the matrix of transformation for basic spinors. Dirac’s equation for the electron is of the form $\nabla^2\psi = k^2\psi$, where ψ is a basic spinor. The same equation, but with ψ representing quantities of other types, occurs in other contexts in quantum theory and nuclear physics.

Dr. Garding sets himself the problem of investigating the generalized equation $S^{-1}V_j T = \sum a_{jk}V_k$, where V_j represents a finite set of matrices, and S , T , and $[a_{st}]$ are any representations of a continuous group, in particular of the orthogonal group with $S = T$. His applications are concerned mainly with the solutions of $\nabla^2\psi = k^2\psi$ for different types of quantity ψ .

In many instances the constructions seem unnecessarily elaborate, and this makes the thesis difficult to read. It would appear very probable that the principal conclusions could be obtained in a more direct manner. Nevertheless, the thesis is very interesting and suggestive, and many detailed formulæ are obtained which in themselves have some value. It shows considerable mastery over many aspects of group representational theory, and many known results are recapitulated incidentally.

The work shows considerable promise, and future publications by the author will be awaited with interest.

D. E. LITTLEWOOD.

Principles of Magnetic Crack Detection

A Practical Treatise specially written for those about to Operate the Process. By H. Bevan Swift. Pp. vi + 105. (London: E. and F. N. Spon, Ltd., 1944.) 10s. 6d.

MAGNETIC methods have proved useful in the detection of cracks, too inconspicuous to be seen without such aid, in steel. This handbook is in the main a description of the apparatus for carrying out such tests in the laboratory or workshop. Several commercial forms of instrument are described, with a general account of the principles of the method. In one type a direct current is passed through the object being tested, and the concentrated field at the edges of a crack is made visible by pouring on a suspension in light paraffin of a highly magnetic preparation of iron oxide. In the second type, suitable for steels with a higher retentivity, a heavy but very short electrical impulse is sent through the object, and the ink is applied afterwards. Only actual experience enables an observer to decide on the significance of the indications given by the magnetic ink, and to distinguish between cracks and accumulations of the magnetic material caused by sudden changes of section or by casual scratches. Methods of demagnetization have to be applied when, for example, parts for aircraft are being tested.

There is a short note on the testing of bars by comparison with a standard, using a null method. Actually, this plan has been used extensively in some works for the testing of small parts, such as chain links, for correct heat treatment, a definite relation being found between the hardness and the magnetic properties, so that a very rapid sorting of correctly from incorrectly treated parts is possible.

ARTIFICIAL PRODUCTION OF COAT COLOUR IN THE ALBINO RAT

ITS RELATION TO PATTERN IN THE GROWTH OF HAIR

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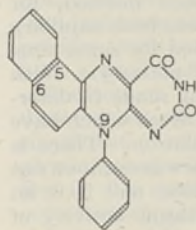
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DURING experiments on growth, which were designed to test the action of a series of flavins, a hitherto undescribed property was encountered in one of these compounds (9-phenyl-5 : 6-benzo-*iso*-alloxazine¹), the structure of which is shown in Fig. 1. Quite unexpectedly, injection of 20–30 mgm. of this substance, in albino rats, produced an orange-yellow pigmentation of the hair. It was then observed that the coloration so produced is usually restricted to certain areas of the coat, in a way which varies considerably from one rat to another, but nevertheless conforms to a characteristic type of pattern (Fig. 2), of which the most striking feature is a pronounced degree of symmetry about the longitudinal axis. Study of some scores of similarly injected rats from the same albino colony soon revealed the regular recurrence of pattern types, which it was comparatively easy to arrange as a roughly transitional series: these facts conveyed a strong impression of a certain unity of design, in which each individual represents only one stage in a continuous rhythmic process. That the pattern which may be elicited in individual animals is variable was proved by administration of the compound at intervals of one to three weeks, fresh zones of colour appearing in response to each such injection: hence its form depends (in the majority of cases at least) upon a fluctuating process, and not upon one which is fixed, or pre-determined, genetically or otherwise.

Relation of Pattern to the Growth of Hair

That the developmental process involved might concern the regeneration of hair was suggested by a number of facts. Dry² recorded that growth of hair on the flank of the rat may be restricted to a strip about half an inch wide running along the length of the body: such a band of growing hair had frequently been observed by the present authors in earlier work, and the irregular distribution of hair regeneration in the rat had also been noted by others^{3,4}. In experiments to test this hypothesis—that the pattern-form is determined by the growth of hair—normal rats were shorn dorsally and laterally from the level of the ears to the root of the tail and down to a low ventro-lateral level, and the subsequent course of regeneration was then plotted, at intervals of a few days. At once it be-



9-phenyl-5 : 6-benzo-*iso*-alloxazine

Fig. 1.

came apparent (Fig. 3) that only limited regions of the coat are regenerating hair at any given moment, that these areas are disposed in a symmetrical arrangement similar to the patterns revealed by injection of the specific *iso*-alloxazine, and that their variety is due to the varying rate of progress of the growth-wave front. It was further observed that the advance of the wave is in general more rapid on the back and belly, and slower on the sides, and that the growth-wave cycle, traversing the surface of the body, is complete in a minimum period of approximately six weeks. But the whole cycle may be greatly disturbed, and prolonged, by factors connected with nutrition, season, lactation, and age. From these experiments it seems probable that the rat coat is replenished by a complex series of regular waves; in individual animals the pattern may be modified by



Fig. 2. COLOUR PATTERN PRODUCED BY TWO INTRA-PERITONEAL INJECTIONS (AT AN INTERVAL OF ONE WEEK) OF 25 MGm. 9-PHENYL-5 : 6-BENZO-*ISO*-ALLOXAZINE IN ARACHIS OIL (FILTER EMPLOYED: ILMFORD TRICOLOUR BLUE No. 304).

isolated bursts of growth, or by a sudden subsidence.

It now appeared that the hair coloration produced by 9-phenyl-5 : 6-benzo-*iso*-alloxazine is due to a localization, in growing hair but not in non-growing areas, of the injected compound or of a derivative; and evidence confirmatory of the latter point was soon obtained from direct examination of the hair pigment itself.

Nature of the Hair Pigment

In order to isolate the pigment, several grams of the coloured hair were treated with glacial acetic acid; after addition of chloroform, removal of the acid with water, and chromatography of the chloroform extract, the hair pigment was obtained as an orange-yellow fluorescing substance, the ultra-violet absorption spectrum of which showed the presence of the injected compound or of some simple derivative which is spectroscopically indistinguishable under the condi-

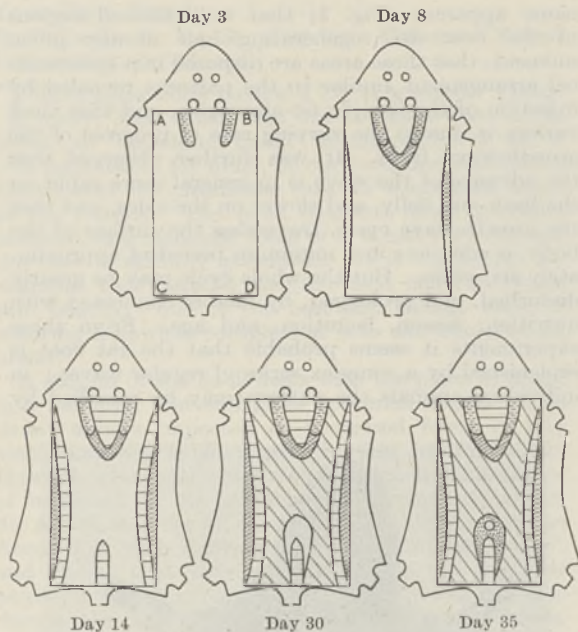


Fig. 3. REGENERATION OF HAIR AT 3, 8, 14, 30 AND 35 DAYS AFTER SHEARING THE AREA OF ABCD. SIMILARLY HATCHED AREAS ARE THOSE IN WHICH HAIR IS GROWING AT THE SAME TIME AND IN WHICH THE ALLOXAZINE PIGMENTATION WOULD DEVELOP IN RESPONSE TO ADMINISTRATION OF THE COMPOUND AT ABOUT THAT TIME.

tions employed; by this means it was calculated that there is approximately 0.1–0.2 mgm. of 9-phenyl-5:6-benzo-*iso*-alloxazine in the fluorescent eluate obtained from 1 gm. of hair.

The derivation of the hair pigment from the administered compound had thus been virtually proved, and an explanation obtained of its selective localization, namely, to those tracts of hair alone which are in active growth at the time of injection.

Mechanism of Localization

It was next found possible to indicate the mechanism of such localization from a study of the blood capillary circulation to the hair follicles, in rats which had previously been sheared as described. Visualization of the capillary system, in permanent preparations (achieved by the injection, under ether anaesthesia, of 1 ml. of a 15 per cent solution of chlorazol sky blue FFS into the femoral vein), revealed that by far the greatest density of capillaries occurs in those positions which correspond to the advancing edge of the growing hair, with a sharp cut-off at the receding edge. This observation is believed to be entirely new; it is, of course, highly suggestive, not only of the means by which the growth-wave progresses, but also of the way in which the circulating pigment enters the cuticle and cortex of the growing fibre. It would seem reasonable to infer that the constantly moving patterns of hair-growth appear in response to rhythmic alterations in the distribution of blood to the hair follicles, so that, as capillaries close down, the growth of hair recedes, while at the same time capillary activity is apparently spreading to other regions, in which the follicles at once react, and growth of hair is resumed. It is also likely that the pigment enters growing areas partly because these are the only ones in sufficiently active interchange with the general circulation. Such an interpretation was strongly supported by capillary

visualization in rats which had been both sheared and injected with 9-phenyl-5:6-benzo-*iso*-alloxazine, all these procedures being carried out within one week in order to obtain near correspondence. By this means it was possible to study capillary density, the position of the wave front, and the pigmented tract simultaneously, in a single preparation, and to show that they have precisely the same distribution.

Some attention has also been paid to the mode of chemical transport of the compound, and particularly whether this might be brought about in combination with cystine in the elaboration of keratin. Direct evidence is here less easily obtained, but it may be said that the alteration in urinary sulphur partition produced by injection of 9-phenyl-5:6-benzo-*iso*-alloxazine (in an experiment by Dr. F. L. Warren) is at least consistent with conjugation between the pigment and cysteine.

Chemical Specificity: Coloration and Absorption

The phenomenon was at first believed to depend upon a high degree of chemical specificity. No pigmentation had been noted in earlier and similar experiments with the first five members of the homologous series of 9-alkyl-5:6-benzo-*iso*-alloxazines, that is, those compounds in which the phenyl group of 9-phenyl-5:6-benzo-*iso*-alloxazine is replaced by a methyl, ethyl, *n*-propyl, *n*-butyl, or *n*-amyl group. Closer inspection has, however, shown that all these compounds do in fact produce slight traces of coat coloration, which is nevertheless far short of the intensity resulting from 9-phenyl-5:6-benzo-*iso*-alloxazine. A very satisfactory direct correlation has been established between the intensity of coloration produced and the excretion of a pigment, for the most part identical with the administered substance, in the faeces and urine: from this it is obvious that the outstandingly active compound is equally outstanding in its rate of elimination. Assuming the rate of output reflects the rate of uptake of the compound from the tissues, it is concluded that the intensity of coloration produced is correlated, within this series, with ease of absorption, and that such is conferred by the phenyl group to a marked degree. Among related substances, a slight degree of hair pigmentation is induced by 9-phenyl-*iso*-alloxazine, that is, the compound differing from 9-phenyl-5:6-benzo-*iso*-alloxazine in the absence of the angular ring.

Other Aspects

In a topic of such obvious and broad interest from both the biochemical and the zoological aspects, many other features have emerged, or are being investigated, relating to the physiology of hair growth and animal pigmentation. For the purpose of the present communication some of these may be summarized more shortly. It has been noticed, for example, that for any group of follicles, both capillary activity and hair growth are inhibited for some time after the cessation of a period of activity. With reference to this, an attempt is being made to determine the effect on the wave front of areas which have been rendered out of phase by epilation. There is also some evidence that the capillary waves move not continuously but in a series of pulses, and it is an interesting possibility that this rhythmic activity of the capillary wave front may be related to some similar rhythm in the sympathetic nervous system. This is especially so in view of a suggestion, based on the observation that concave sections of the wave

front occasionally tend to 'fill', and so smooth themselves out, more rapidly than the entire front advances, that the movement is dependent upon the release in the tissues of a chemical substance, which might accordingly reach a higher local concentration in the troughs of the pattern than at the crests. However, such a neurohumoral mechanism still remains to be fully tested by experiment.

The pigmentation phenomenon is being studied further in relation to sex, age, genetic constitution, and species. It has been noted that the intensity of pigmentation following injection tends to be slightly greater, other factors being equal, in male rats than in females. In practically all cases the pattern evoked was of similar type and behaviour in hooded rats (of constitution *CCss*), in coloured rats (*CCSS*), and in albino rats of the constitutions *ccss* and *ccSS*: thus there is no indication that the pattern revealed is related to a genetically determined pattern already present, whether manifest or latent. (For assistance in the isolation of these genotypes we are much indebted to Dr. P. C. Koller.) Some allusion may also be made to the possible affinity between the capillary and hair-growth pattern in the rat, and striped or banded pigmented patterns in other mammals.

So far as the behaviour of 9-phenyl-5:6-benzo-*iso*-alloxazine in other species is concerned, only brief mention may here be made of its effects in mice. No action of any kind has been observed following administration of the compound (by injection or by feeding) to stock albinos or mice of the *R* III and Strong *A* pure lines. On the other hand, prolonged feeding (over many months) to black-eyed or so-called 'dominant' whites has apparently resulted in a slow increase of yellow pigmentation, although only very slight in intensity, confined to the dorsum and flanks. It by no means follows that the *iso*-alloxazine most effectively absorbed by growing rat hair is likely to be the most penetrating in other species, and having regard to the interest which would attend any extension of the phenomenon to mice, other compounds are being studied with this consideration in view.

Lastly, from the chemical side alone a wide field of inquiry can be opened up. How far molecular constitution may be modified, while still retaining this curious property, and how far the colour of the pigments themselves can be varied, within these limits, have so far only been studied in a very preliminary way. However, data have already been obtained concerning various colourless degradation and oxidation products of 9-phenyl-5:6-benzo-*iso*-alloxazine, which may conceivably have some bearing upon the chemical basis of albinism. Also, it may be of importance to relate these synthetic compounds to the so-called 'xanthic' pigments, of both known and unknown molecular structure (and including the butterfly wing pigments and other pterins), such as possess physiological importance or have a wide distribution in Nature.

Poulton, in his book on the colours of animals⁵, directed attention to what he classified as 'non-significant' colours, that is, pigments without physiological value in respect of their colour as such. But he also stressed their importance, as the material out of which natural selection can create 'significant' colours, namely, those with special functions in protection, concealment, mimicry, adornment, and so on. We may conjecture that if a mammalian species, in which the growth of hair followed the same rules

as apply in the rat, were to form a pigmented metabolic product with the properties of the *iso*-alloxazine, coat colour would inevitably result. It is then a legitimate surmise, following Poulton, whether such an arrangement might not become genetically fixed, or subject to natural selection, and thus confer some permanent biological advantage, protective or otherwise. This, however, is a matter of speculation. So far we can only say that the alloxazine colouring is adventitious and artificial, but may be potentially significant, in Poulton's sense, as well.

It is hoped in due course to publish a fuller account of this investigation elsewhere.

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³ Emmens, C. W., *J. Endocrinology*, 3, 64 (1942).

⁴ Cunha, T. J., Kirkwood, S., Phillips, P. H., and Bohstedt, G., *Proc. Soc. Exp. Biol. Med.*, 54, 236 (1943).

⁵ Poulton, E. B., "The Colours of Animals" (London, 1890).

DORMANCY IN BRITISH-GROWN WHEAT

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BEFORE the War, only a relatively small percentage of the wheat used in bread in the British Isles was home-grown. During the War, however, the acreage of home-grown wheat has more than doubled, and a large proportion of this wheat is used in bread-making grists (on occasions as much as 60 per cent of the grist). This in turn has raised the question of the most suitable varieties for bread-making. Unfortunately, this is not a simple question to answer since the quality of wheat is influenced by season and environment. Nevertheless, the National Institute of Agricultural Botany has recently issued a report giving broad recommendations based on the results of trials carried out over a long series of years.

In 1941 and particularly in 1944, a further problem arose. The weather at harvesting was unusually wet, and as a result much of the wheat sprouted in the field. As is well known, the effects of sprouting on the commercial value of a wheat crop are serious. Not only is the grain useless for seed, but also its value for milling purposes is greatly impaired. The enzymes produced during germination reduce the baking quality of flour, giving rise to undesirable characteristics in dough and bread which cannot be rectified by treatment. The diastatic activity of a wheat (normally expressed as the 'maltose figure') is a measure of the extent of germination, and in an effort to lessen the damaging effects of sprouted home-grown wheat the Ministry of Food issued instructions that no wheat must be used with a maltose figure exceeding 3 per cent. Even so, this type of damage in varying degree has been evident in much of our bread—the crumb is doughy and the loaf cuts badly—and in routine surveys of the quality of commercial bread during November and December last, as much as 25 per cent of the bread was affected.

The ease with which a freshly harvested seed germinates is linked up with the extent to which it shows dormancy; some seeds will only germinate after a prolonged period of dry storage. The phenomenon has received attention from several investigators, notably Harrington¹ and Crocker². Crocker

has pointed out that most species of wild seed can show a very prolonged dormancy which serves as a natural protection for the preservation of the species. In cultivated varieties the phenomenon is far less evident but still persists in varying degrees. The frequent occurrence of dormancy in home-grown new crop barley, especially in the colder and damper north of Britain, is well known to maltsters, who find it necessary to dry such grain in a kiln and store it over a period of weeks or even months to secure the rapid and even germination essential to their process. Bishop³ has also recently recalled the observation of Duchartre⁴ on the variations of the germinative energy of barley at, and about, harvest time. Duchartre noted that while barley grain in the milk stage was capable of germinating readily under suitable conditions, upon ripening the power of rapid germination steadily diminished, passed through a minimum, and thereafter improved to a maximum from which it was very slowly reduced with age. It is, therefore, usual to distinguish the ripe stage of barley, at which it is ready for harvest, from the so-called mature stage at which it is able to germinate readily, and the recovery process is termed 'maturation'. The length of the dormancy period and the rate of maturation are usually considered to be a function of the conditions of temperature and moisture content in which the grain finds itself; a warm, dry condition hastens maturation, and conversely cold and damp retard it. However, in any sample of dormant grain, representatives of all stages of dormancy are usually to be found; hence germination tests show uneven response with time, and are, of course, liable to considerable sampling error.

Little attention has hitherto been paid to the study of dormancy in English wheat. In general, it appears to be less evident than in barley, though from our own observations it follows a similar course. During the past season, we have been fortunate enough to obtain from Rothamsted Experimental Station samples of both Als and Vilmorin wheats during seven weeks covering a period immediately prior to and following upon the cutting of the crop. Many grains of the earliest samples when first removed from the ear and planted showed rapid germination, a capacity which they lost almost entirely after a short period of drying in the sun. The later samples of wheat showed pronounced dormancy but with gradually increasing recovery which was almost complete in the last sample. By this time grain from the first sample, which had been stored air-dry in the laboratory, had also matured. It is clear that the tendency of grain to sprout during harvest will depend not only on the atmospheric conditions but also on its state of dormancy. When hot dry weather, which will hasten maturation, is followed by rain, conditions are most favourable for sprouting; in a cold damp season grain is likely to show less tendency to sprout in a rainy harvest. It must, however, be realized that if favourable conditions prevail for a sufficiently lengthy period, even very dormant grain will eventually germinate unless some external agency such as mould intervenes to make an end.

During the past harvest season, we have been able to carry out a preliminary investigation on the degree of resistance to sprouting exhibited by several varieties of wheat. By the kindness of Mr. H. W. Gardner, Hertfordshire Agricultural Institute, we were able to examine samples of nine wheat varieties grown, with and without nitrogenous supplement, side by side on three different sites selected for

differences of soil condition. On the first of these sites the crop had been cut, stooked and carried in good weather and had escaped sprouting. On the other two, harvest conditions had been by no means so good, wet weather causing a degree of sprouting in several instances. Weight percentages of sprouted grain separated by the hand-picking of sub-samples weighing not less than 80 gm. are set out in the following table.

Variety	Percentage sprouted grain				
	Site II		Site III		
	No nitrogen	Nitrogen added	No nitrogen	Nitrogen added	Nitrogen added
Holdfast	39.7	24.4	27.1	26.8	26.8
Steadfast	42.6	48.6	34.0	19.9	19.9
Juliana	30.1	25.8	7.8	12.2	12.2
Squarehead's Master	18.1	16.7	4.1	1.6	1.6
Scandia	17.6	7.3	4.2	2.3	2.3
Weibull's Standard	3.8	8.4	1.0	1.2	1.2
Desprez 80	19.7	23.0	1.7*	0.5*	0.5*
Vilmorin 27	2.9	0.9	4.1	6.1	6.1
Little Joss	6.1	6.4	2.6	4.0	4.0
Total average ..	20.05	17.95	9.6	8.3	8.3

* Desprez 80 from Site III was immature and thus very dormant, as with unripe grain after sun-drying. Results for Site II are probably a truer indication of the tendency of this variety to sprout.

These results indicate, as might be expected, that nitrogenous manuring has no substantial influence on the dormancy period of wheat, the small differences shown in the table being probably adventitious. On the other hand, as between varieties, Holdfast, Steadfast and Juliana seem especially prone to sprout, a tendency accentuated on Site II where harvest conditions were even more severe than on Site III. Squarehead's Master seems to occupy an intermediate position, while Little Joss, Weibull's Standard and Vilmorin 27 appear to be much more resistant. This conclusion has been to some extent confirmed by the examination of isolated individual samples from other sources, which suggest that while soft white wheats such as Wilma and White Victor sprout readily, Als, Ate, Iron II, Redman, 60 and Bersée are resistant.

Further confirmation of some of our findings has been communicated privately to us by Dr. Hunter, of the National Institute of Agricultural Botany, who has noted that during the harvest of 1944 sprouting trouble was especially prevalent in Holdfast, Steadfast and Juliana.

It has to be admitted that our data are at present insufficient to decide as between varieties on their relative dormancy periods. It is hoped, however, to obtain such information during the next season. In considering the preliminary data, it has to be remembered that all varieties were reaped and carried at the same times, and hence the earlier ripening varieties have been exposed to a more severe test. As regards breadmaking quality, it is disconcerting to find that the majority of the resistant wheats are generally thought to be poor. On the other hand, it has recently been suggested by Johnston^{5,6}, and by Harrington and Knowles⁷ that dormancy may be an inherited character. If such be true, it should offer possibilities to the plant breeder, and in fact, in the case of barley, Freistedt⁸ has already directed attention to this.

The general problem would appear to be one of some importance if we continue to grow wheat in Britain for bread-making.

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² Crocker, W., *Amer. J. Bot.*, 3, 99 (1916).

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⁴ Duchartre, C., *C.R.*, 35, 940 (1852).

⁵ Johnston, L. P. U., *Can. J. Res.*, 13 C, 367 (1935).

⁶ Johnston, L. P. U., *Can. J. Res.*, 13 C, 283 (1935).

⁷ Harrington, J. B., and Knowles, P. F., *Sci. Agric. Ottawa*, 20 (6), 355 (1940).

⁸ Freistedt, P., *Z. Züchtung A*, 20, 169 (1935).

UNIVERSITY REFORM IN BRITAIN

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UNIVERSITY reform is in the air to-day. The amount of discussion about the future of higher education that is going on among thinking people—and to-day a greater proportion of citizens are thinking than usual—cannot but do good. Isolationism—the 'ivory tower' conception of the role of the university—has always been liable to become a limiting factor in its usefulness.

The National Union of Students has recently discussed the subject, and has issued a report*, the chief characteristic of which is its entire reasonableness. One somehow expects student opinion to run to extremes, usually to the Left. It would indeed be unnatural if youth were satisfied with the present condition of affairs. But all the suggestions put forward here are in my own opinion worthy of thoughtful consideration by university authorities.

Here, as elsewhere, the abolition of fees tends to become a fetish or King Charles' Head. Education for all who are worthy to the limit of their need and powers is a first-rate end; but I do not believe that, in our present state of society, abolition of fees is the best means to that end. Nor is it likely to be for some time. There are very many people to-day who can afford to pay for their university career. Many find pride in doing so. Unless we drastically change our methods of selection—getting away from the purely intellectual sieve—we should, if we exclude fee-paying students, lose a valuable element of student life. Oxford and Cambridge in particular have benefited from the leavening influence of many men who would not have reached a university on intellectual qualifications alone, and no one has benefited more from their presence than the scholars themselves.

Also, while our society is so constituted that men exercise influence more than the average through accident of birth and wealth, it is good that they should, as part of their education, live in a university atmosphere for some years. Again, government is not yet so conditioned that the universities would not be financially crippled if fees were eliminated from their income. First we need the Government and local authority grants doubled and doubled again. I am therefore against the abolition of university fees. The time is not nearly ripe. What would be the value of flooding impoverished universities with students for whom we cannot cater properly, while excluding men and women all of whom to-day have to prove their intellectual fitness for university education through entrance examination; many of whom select themselves on other grounds better than some scholars, and most of whom, as society is organized to-day, are going to play an important part, and should have the best possible preparation. The abolition of fees in universities might be a proper and necessary feature of a social revolution; but as an incident of university organization to-day it is premature and out of place. Let us, on the other hand, have more generous maintenance allowances and more scholarships. Most of our anticipated expansion in numbers should derive from that source.

The need for, and value of, a high standard of character and personality as well as intellect in university personnel—be they staff or students—make the more important one recommendation that I can heartily endorse: compulsory residence for one year at least. I would go further and ask for two as a minimum. It is a debatable point whether, if only one is required, the freshman year is the best. Different colleges at Oxford and Cambridge hold different views about this.

An interesting point raised is the question of student representation on university governing bodies. At the University of Birmingham students are represented on the Court. This is a good thing, but it means very little in practice. At the University of Melbourne they are represented on the Council. That was never an embarrassment to the University during my tenure of the vice-chancellorship, and I do not believe it had been before. What the National Union of Students means by direct access to council, senate and faculties is not clear; but I do not believe any such body would refuse to see a deputation of students if asked, certainly not in any university on the staff of which I have served. I agree, however, with the Union that the most promising method of integration is through staff-student committees. I think few heads of departments, if properly approached, would refuse to participate in such discussion groups. A good example of this sort of co-operation is the Arts Council at the University of Birmingham.

The revolt against over-lecturing is natural, but can, I think, be overdone. Spoon-feeding would be as bad as under-nourishment. Let us have more seminars and informal tuition by all means. I have tried out the cyclostyled notes idea, and on the whole it was not a success. It was useful occasionally for broadcasting diagrams or charts, or especially difficult arguments; but used as a general rule it made for slackness and inattention, at least in some subjects and with certain types of students. I can imagine, however, that the issue of regular notes might be valuable in certain subjects. Personally, I would rather have students stay away and read than be compelled to attend lectures in which they are not interested. In this, as in many other things, however, a vice-chancellor carries less weight than professors, and he must defer to their specialist knowledge of teaching.

For the rest, a vigorous student union, as autonomously governed as possible, is an essential requisite for satisfactory life in the non-residential university. The sad thing to-day is the fact that the educative influence of the union is confined to a minority of students. The majority use the building only as a restaurant, lounge and dance hall. Only student opinion and student influence can remedy this. Many never go near the union at all. They are the 'brown baggers' of whom we hear so much. The only answer to them is compulsory residence in halls of residence generously equipped with a staff whose interests are student-centred, and with the amenities that foster community spirit and social activity.

I would agree with the estimate that student numbers in British universities should be increased over all by 50 per cent; though, since Oxford and Cambridge are near saturation point, this will mean doubling the size or number of the provincial universities. The remarks made about the curriculum are well worth study by university senates, which are, indeed, not unaware of the need for reform.

* The Future of University and Higher Education: a Report prepared by the National Union of Students of the Universities and Colleges of England and Wales. Pp. 16. (3 Endsleigh Street, London, W.C.1, 1945.) 6d.

Many faculties are vigorously discussing these questions now.

Nearly all the proposals in what is a useful and provocative little booklet mean greater expenditure. We must hope that those who hold the purse-strings will realize that to-day the universities are a long way behind scratch. The greater part of the first increases of grant will be expended in bringing us back into line for a good start after the backsliding made inevitable by six years of war.

It has been difficult to review the report issued by the National Union of Students in a short article: it is quite impossible to do justice to the many subjects touched upon at the Second Educational Conference of the Association of Allied Professors and Lecturers, held in London on April 14, 1944, the proceedings of which are now available*. Mental indigestion and a seething mind are inescapable after a first reading. There are, however, some impressions that pick themselves out. The modern Soviet university seems to have got farthest from the 'ivory tower' idea, but this has been incidental to profound social and political changes. Unless we are prepared to follow them in the larger field—and I for one think that we should lose more than we should gain by doing so—we must seek to attain the same end by more devious ways. The United States are trying hard to achieve an educated democracy and have had a measure of success. It has been easier in a country with an expanding frontier than it has been in overcrowded Western Europe with its bounds set by history and tradition. It will be less easy in the America of the future, when the expanding frontier will be a memory of the past. When I visited the United States in 1936, the Federal Government was spending sixty million dollars a year on student maintenance, because it was becoming progressively more difficult to work one's way through college in competition with the regular labour force.

I like Sir Fred Clarke's definition of training as "the cutting edge that makes education specifically

serviceable'. General acceptance might give the word and idea a new lease of respectable and useful life. Interchange on the Francqui chair scale, with its fully equipped laboratory and specialist assistants for the visiting professor, approaches the ideal, and is linked in my mind with the good idea of occasional interchange between the professor and master of the school sixth form. The greatest professors like taking elementary classes despite what Bruce Truscott says. It is not too great a step to go back to school, though the step would certainly be new. The American system of sabbatical leave and the junior's *wanderjahr* have done much for peaceful penetration into China, and the British Commonwealth might well emulate their trans-Atlantic cousins here. Of the great university dangers, 'specialization, mechanization of learning, and interference by the State', we in Britain know something of the first two, but we have steered clear of the third thanks to our genius for anomalies in our government set-up. Long may that remain true.

Sir Ernest Barker has likened the ancient universities to mountains of ice nine-tenths submerged in seas of history and tradition. Having had experience of Antarctic exploration, I am tempted to carry the analogy a step further. The new universities are more like the snowbergs from the Antarctic continent with half their bulk above water. They may have a more workmanlike façade, if a different one. They are without the peaks and pinnacles, but there is something to be said for a solid rectangular shape. They are more responsive to the winds of public opinion. They are more readily adaptable to the social environment in which they are set. These are, on balance, not bad characteristics. I will not press the analogy too far, for icebergs and snowbergs alike, when they grow older, pass through the stage of being hidden dangers to navigation, and finally they disappear leaving no trace.

* Association of University Professors and Lecturers of the Allied Countries in Great Britain. Second Education Conference, April 15, 1944: Some Comparisons between Universities. Pp. xvi + 64. (Oxford: Basil Blackwell, 1944.) 2s. 6d. net.

NEW FELLOWS OF THE ROYAL SOCIETY

THE following were elected fellows of the Royal Society on March 14:

MR. L. COLEBROOK, a member of the scientific staff of the Medical Research Council. Distinguished in the application of bacteriology to clinical medicine, he played a leading part in the practical establishment of the 'sulpha' drugs, and has thrown much light on the fevers of childbirth. During the War he has directed important investigations on burns.

MR. W. S. FARREN, aeronautical engineer, director of the Royal Aircraft Establishment, Farnborough. He has been associated with aeronautical research and development continuously since 1914, and has contributed greatly to advances in the science and practice of aeronautics.

DR. N. FEATHER, lecturer in physics in the University of Cambridge; distinguished for investigations which have added much to knowledge of the spontaneous and induced disintegrations of atomic nuclei.

PROF. J. H. GADDUM, professor of pharmacology in the University of Edinburgh; distinguished for his work on the identification and estimation of acetyl-

choline, adrenaline and histamine in animal tissues and for his experimental contributions to the conception of cholinergic and adrenergic nerves.

DR. H. GODWIN, lecturer in botany in the University of Cambridge; distinguished as a plant ecologist, and especially for his contributions to the knowledge of the post-glacial history of British vegetation based on the pollen analysis of recent deposits.

PROF. J. M. GULLAND, Sir Jesse Boot professor of chemistry, University College, Nottingham; distinguished for his analytical and synthetic work in the phenanthrene group of alkaloids, and for his work in the development of the chemistry of substances of biological importance.

MR. H. W. HARVEY, marine biologist; distinguished for his contributions to our knowledge of the 'productivity of the sea' by co-ordinating the varied factors, physical, chemical and biological, which determine it.

PROF. V. C. ILLING, professor of oil technology in the Imperial College of Science and Technology; distinguished for his researches on the relation of texture of sediments to oil accumulation, and for

refinements of stratigraphical and geophysical methods applied to interpret the structure of oil-bearing lands.

MR. A. E. INGHAM, University lecturer in mathematics in the University of Cambridge; distinguished for his researches in pure mathematics, particularly in the theory of numbers.

PROF. H. D. KAY, director of the National Institute for Research in Dairying; distinguished for his biochemical work, particularly for his investigations upon organic phosphorus compounds and the phosphatases. Recently he has applied his methods to the practical problems of dairying.

DR. W. B. LEWIS, lecturer in physics in the University of Cambridge; distinguished both for his contributions to the investigation of the structure of atomic nuclei and also to the development of the science of electronics, with special relation to ultra-high frequency radiation.

DR. KATHLEEN LONSDALE, physicist, Royal Institution; distinguished for outstanding contributions to the investigation of the crystalline structure of organic compounds by means of X-ray analysis. Particularly important have been her recent researches into the fundamental mechanics of crystal structure.

PROF. P. C. MAHALANOBIS, professor of physics, Presidency College, Calcutta, and founder of the Statistical Laboratory, Calcutta; distinguished for his contributions both to statistical theory and to the applications of statistics, particularly to sample surveys, agriculture and population.

PROF. R. E. PEIERLS, professor of applied mathematics in the University of Birmingham; distinguished for his contributions to theoretical physics, particularly in the application of quantum mechanics to the electron theory of metals and other phenomena of the solid state, and in the theory of the atomic nucleus.

PROF. J. MONTEATH ROBERTSON, Gardiner professor of chemistry in the University of Glasgow; distinguished for his work on crystal structure by the methods of X-ray analysis. He has made measurements of great accuracy in this field, and has derived from them precise molecular structures, electron density distributions, and inter-atomic distances of organic molecules.

PROF. F. M. ROWE, professor of colour chemistry and dyeing in the University of Leeds. As leading dyestuff technologist, his work has been of national importance. He has made varied and original contributions to the chemistry of dyes and intermediates.

SIR WILLIAM WRIGHT SMITH, King's botanist in Scotland, regius keeper of the Royal Botanic Garden, Edinburgh, and regius keeper of botany in the University of Edinburgh; distinguished for his contributions to the taxonomy of Angiosperms, and especially for his monographic treatment of the genera *Primula* and *Rhododendron*.

MARJORY STEPHENSON, a member of the scientific staff of the Medical Research Council; distinguished for her biochemical researches upon the metabolism of bacteria, which, with those of her pupils during twenty-five years, have included work upon hydrogenase, lactic dehydrogenase and adaptive enzymes.

MR. B. N. WALLIS, mechanical engineer, chief of research and development of Vickers-Armstrong Ltd., Aircraft Section. He has been responsible for many new projects of design, and his work has led to secret developments which have been of great importance in the war effort.

MR. J. Z. YOUNG, lecturer in zoology in the University of Oxford; distinguished for his outstanding contributions to knowledge of the nerve fibre, both of its structure and function. During the War he has worked on important clinical aspects of the repair of damaged nerves.

NEWS and VIEWS

Prof. Guido Castelnuovo

MATHEMATICIANS will be pleased to learn that Prof. Guido Castelnuovo, formerly professor of geometry in the University of Rome, is safe and well. In a recent letter to Mr. L. Roth, of the Imperial College of Science and Technology, London, he relates that he, with members of his family, obtained refuge during the German occupation of Rome, and that he has now returned to his well-known house in the Via Boncompagni. Castelnuovo is eighty years old this year; the world of science will unite in congratulation. Castelnuovo's work (which was reviewed in *Nature* of December 10, 1938, p. 1016) represents the best in Italian geometrical thought over a long period. Born in an age which, to quote his own phrase, "closed one epoch and opened another", his first papers were, naturally enough, on the projective geometry of higher space. But soon, with Corrado Segre, he was making essential contributions to the algebraic geometry of curves which, sixty years ago, was beginning to assume its modern form. Then, in 1894, with Federigo Enriques as his collaborator, he initiated the study of the algebraic geometry of surfaces, on no firmer a foundation than the hints and conjectures (some of them mistaken) of Max Noether. Much of this work is definitive, in a negative as well

as in a positive sense; for where he has paused, his successors in the field have often found it impossible to progress. Perhaps the most celebrated of Castelnuovo's papers is the memoir of 1896, in which he gives necessary and sufficient conditions for the rationality of a surface, that is, for the existence of a one-to-one algebraic correspondence between the points of the surface and those of a plane. Incidentally, this was quite literally a piece of research, in that the author did not suspect what the conditions were before he began to write the paper. So the theory of rational surfaces was able to take its place by the side of the classical theory of rational curves.

Already (and, in fact, during the previous ten years), Italian geometers were posing similar questions for the threefold, that is, the locus which is represented analytically by an equation in four co-ordinates. The quadric threefold, like the quadric surface, is easily seen to be rational by projecting the locus from a point of itself. It was also well known (though the proof is less obvious) that the general cubic surface is rational. The question now arose, what could be said about the general cubic threefold? The question was destined to become one of the historic problems of geometry. At first glance one could see that the answer would either be imme-

diate or else very difficult to obtain. A first attempt fell wide of the mark: Segre, in his great work on cubic threefolds, written about 1887, had tried to grapple with the problem; but it turned out that the varieties he considered, though rational, were not general of their type. The problem was then taken up by Prof. Gino Fano, of Turin, one of Castelnuovo's first pupils. In a struggle which has lasted some fifty years, Fano has made vital contributions to the subject, culminating last year with the news, in a letter from Switzerland, that he had succeeded in showing that the general cubic threefold is irrational. It would be an under-statement to say that geometers await with impatience the appearance of Fano's investigation.

Miss P. M. Taylor

MISS P. M. TAYLOR, who has recently been appointed woman educational officer to the Central Council for Health Education, was educated at Girton College, Cambridge, and Westfield College, London. Miss Taylor joined the executive committee of the Association of Women Science Teachers in 1932, and in 1935 was elected honorary general secretary, in which capacity she served until October 1944. Her new position with the Central Council is an important one which necessitated her relinquishing the onerous duties of the general secretaryship of the A.S.W.T., though she was re-elected to the Executive Committee this year. The present investigations of the Association, which have already resulted in the publication of the pamphlet "Pre-Nursing Course in Schools" (1943) and the Interim Report on Science in Post-Primary Education (1944), are in a large measure due to the initiative and exceptional powers of organization of Miss Taylor. The Association is fortunate in having her continued co-operation in the completion of this work, the results of which it is hoped to publish shortly. Miss Taylor's zeal is unabated, in spite of the calls made upon her and her capable assistants during the war years to keep in touch with the members. Their success is seen in the vigorous growth in membership and the widespread interest in progressive methods of science teaching, which factors have necessitated the appointment of a full-time secretary. In addition to her work as honorary general secretary, Miss Taylor has served on the Education Advisory Committee of the Central Council for Health Education, the Consultative Committee to the Nursing Reconstruction Committee, Royal College of Nursing, and as president of the Essex Branch of the A.W.S.T. She held the post of senior science mistress at the Southend-on-Sea High School for Girls until July 1944.

Agricultural Zoology in Scotland

DR. D. S. MACLAGAN, lecturer in zoology at King's College, University of Durham, has been appointed head of the Department of Zoology of the West of Scotland College of Agriculture, Glasgow, and research advisory officer in agricultural zoology for the southwest of Scotland, in succession to Prof. L. A. L. King, who has retired. Dr. MacLagan held a Ministry of Agriculture research scholarship during which he carried out work at the Parasite Laboratory of the Imperial Bureau of Entomology and at Harvard University, and later worked with a Carnegie research fellowship at the University of Edinburgh. He is known for his work in animal ecology and on the dynamics of animal populations.

Cosmic Ray Investigations in Armenia

THE preliminary results of the Alagez Expedition of 1944 for the study of cosmic rays have been published in the U.S.S.R. Observations have been made each year since 1942 from a camp on Mt. Alagez in Armenia at a height of about 10,000 ft. above sea-level. All instruments, supplies and camp equipment had to be carried on pack animals. As conditions are extremely favourable for the study of cosmic rays, it has now been decided to build a permanent station there, with an observation post at about 13,000 ft. It is now believed that cosmic rays contain a third element in addition to mesotrons and electrons. The particles which make up this third element have a greater ionizing effect on air than either mesotrons or electrons. The latest expedition spent three months in attempting to discover the nature of this third component, especially the mass of the particles of which it is composed. The difficulty was to separate them from the other already known components. New methods were evolved, and some new and extremely sensitive instruments built. The particles were found to have properties very similar to those of protons. The part they play is apparently more significant than was at first realized. Only preliminary data, however, have been obtained, and the material is still being studied. The expedition made several thousand observations during great cosmic ray showers for the purpose of determining the energy of the cosmic particles which cause the showers. It was found to be enormous. A special kind of shower, occurring over a very small area, but including a tremendous number of particles, was also discovered.

Stone Age Implements in India

INDIA is rich in relics of Stone Age man, and the prehistorian there has a wide field for research. Not a great deal of new information will be gleaned from "Pre- and Proto-history of Gujarat" (H. D. Sankalia, reprinted from "The Glory that was Gūrjaradesa", 1943), though the gazetteer of finds at the end of the article is useful so far as it goes. What the prehistorian asks from researchers in the field in India is definite stratigraphical data. Perhaps, therefore, the geological section of the right bank of the Sabarmati River at Pedhāmlī appearing on p. 15 is the most important single item in the article. It would seem that, as throughout Madras, early Stone Age artefacts come from a gravel conglomerate which rests immediately upon laterite. The occurrence of a microlithic industry suggests that its makers were using composite tools in which several 'pigmy' flints were hafted together to form one efficient instrument. Such industries appear at various different periods when natural circumstances permit or encourage their development and may be of widely different ages; and one must enter a caveat against the wisdom of trying to correlate the microlithic finds of Gujarat with those of Europe. In India itself, Colonel Gordon, in "Indian Art and Letters" (1936), has shown that the rock-shelter paintings in the Mahadeo Hills are not very old—maybe first century B.C. to tenth century A.D. in date. There the only industries found in the rock-shelters below the paintings consist of typical Indian pigmy artefacts. Near the surface a little pottery occurs; in lower levels this is absent. The conclusion would seem to be that the pigmy industries themselves are not very old and certainly nothing to do with the European Mesolithic either culturally or in time. This is also true of the numerous

microlithic industries in quartz found in Ceylon. Dr. Sankalia ("The Second Gujarat Prehistoric Expedition: A Preliminary Account of the Search of 'Microlithic Man in Gujarat'," by H. D. Sankalia and I. Karve, *New Indian Antiquity*, 7, No. 1; April 1944) has described the unearthing of some skeletons, believed to belong to the folk who made the pigmy objects described. Physical anthropologists will naturally await with interest a complete account of these finds when the final study of them has been made.

Community Centres

THE report on community centres recently prepared by the Ministry of Education (Pp. 40. London: H.M. Stationery Office. 9d. net) is a document of much importance. The Government has decided that the provision of such centres to promote the social and physical training and recreation of the community should be regarded as coming within the scope of the education service administered by local education authorities, such provision being covered by Section 53 of the Education Act, 1944, without prejudice to the power of other local education authorities under Section 4 of the Physical Training and Recreation Act, 1937, to provide centres for athletic, social or educational objects. Arising out of that decision, this report has been prepared at the instance of the Minister of Education by some of his officers, and is now published for general information. The first chapter of the report goes at once to the root of the matter. "During the present century, the day-to-day life of the British people has been profoundly affected by two parallel and closely related developments—the mechanisation of industry and a progressive reduction in working hours. The reduction in working hours may have been largely due to the growing demand for more leisure, but it was mechanisation which made it possible to meet the demand". That is the point of departure taken in this searching and comprehensive report; that, and another fact plain to be seen, that it is one thing to have spare time and another to know how to use it wisely. Though the report does not expressly say so, it means that we have reached a position in which the twofold distinction between work and leisure should be replaced by a threefold distinction between (1) work, done for a living, whether one likes it or not, (2) relaxation, play, recreation, for the recovery of poise, and (3) true leisure, spent upon pursuits which may make it in one way or another "the growing time of the spirit". In subsequent chapters the report goes into detail about the organization, staffing, provision and maintenance, and ownership, control and management of community centres. A valuable appendix sets forth the suggested accommodation required for neighbourhood units in varying situations.

Control of Rabies

IN an interesting leading article, the *Lancet* (628, Nov. 11, 1944) directed attention to the need for the existing regulations designed to prevent the reintroduction of rabies into Great Britain. The law requires that all dogs imported, by air or otherwise, shall be quarantined for six months; strict insistence on this regulation would prevent the reappearance in Britain of this serious disease. Rabies is primarily a disease of dogs, cats and allied species; but it is communicable to man and to domesticated animals by the bite of a 'mad' dog. It was first recorded in Great Britain in

A.D. 1000; but it probably existed here before that date. In the middle of the eighteenth century it raged among dogs in London and elsewhere. In the nineteenth century it broke out among several packs of fox-hounds, and some thirty-six persons a year died of rabies. By 1902 rabies had been eradicated from Great Britain by stringent control measures, and it did not reappear for sixteen years. By then (see Stockman, S., *Vet. Record*, 32, 135; 1929, quoted by the *Lancet*, *loc. cit.*) the public was so unfamiliar with the disease that some sections of it failed to realize the dangers of its reintroduction, and the abnormal conditions of that time doubtless helped its spread.

Rabies was found among dogs in Great Britain in September 1918, the infection having been brought in by smuggling dogs into the country by air. The Ministry of Agriculture took energetic measures against it, and these measures were helped by the fact that most of the dogs were affected by the dumb or paralytic form of the disease, which greatly restricts their wanderings and ability to bite, and also by the fact that the disease broke out in Cornwall, which is isolated to some extent from the rest of England; most of the affected dogs wandered west to the sea. Nevertheless, some seventeen counties became involved, 327 dogs died of the disease and 368 human beings were bitten and had to be treated. The outbreak was not controlled until December 1921 (see *Lancet*, ii, 719; 1926). In the United States, during the last ten years, there has been an average of fifty-seven cases a year, and some States have recorded more than a thousand cases a year among animals. Rabies vaccines are available, and the *Lancet* (628, Nov. 11, 1944) discusses the value of these, which has been questioned. Meanwhile it cannot be too widely known that rabies will, if it comes again to Great Britain, cause much suffering among men and animals. The quarantine regulations, which can keep rabies out of the country, should therefore be vigorously supported.

Stars or Planets ?

PETER VAN DE KAMP has an article with this title in *Sky and Telescope* of December 1944, in which he deals with the question of the criterion for stars and planets—a matter of considerable importance in view of the fact that recent discoveries have shown the existence of 'planets' fifteen or twenty times the mass of Jupiter. He accepts Russell's critical value of 1/20 of the sun's mass as a conventional borderline between visible stars and the invisible bodies which can be designated as 'planets'. This criterion defines a planet or star, therefore, by its mass, not by its size. Among the methods for detecting unseen companions of low mass is the photographic method applied to nearby stars, and if the determination of the orientation of the perturbation orbit were sufficiently accurate, good results would be obtained. Difficulties arise from the fact that photographic star images are 1"-3" in diameter, and most of the recently discovered perturbations have a total amplitude of less than 0.1". The gravitational method for discovering faint companions of low mass, while it is more powerful than the direct visual approach, has decided limitations for very low masses, and it would be extremely difficult by this method to find companion masses less than 1/100 times the sun's mass, even for the nearest stars. The star which seems unattended by dark companions may be the exception, and it is possible that the stars attended by massive companions, rather than by small planets,

are in the decided majority. Our solar system may prove to be an extreme type of system, rather than an average type. Though generously endowed with planets, the sun is the only star known that has no close companion star.

Optical Phenomena in the Atmosphere

L/CPL. V. S. TAYLOR, 6 Field Park Coy., R.E., C.M.F., writes: "The discussion on optical phenomena in the atmosphere in *Nature* of December 9, 1944, brings to mind an occurrence frequently witnessed at Anzio while it was a beachhead. During, and immediately after, intense A.A. fire under conditions of virtually clear sky, with the sun behind the observer, concentrically disposed wave ripple arcs could be seen passing away from the barrage zone, in the portion of the sky about 45° forward of the observer. The acute compression of the atmosphere peripheral to the bursting shells caused the compression zones to be sufficiently altered in refractive index to produce an optically visible phenomenon when refracting undiffused sunlight." This phenomena would seem to be similar to the concentric waves observed by Dr. A. H. Goldie following a bomb burst (*Nature*, 154, 738; 1944).

Post-War Bread in Britain

THE Ministry of Food, in collaboration with the Health and other Departments interested, has arranged a conference with the industrial and trade organizations principally concerned with post-war bread. It is hoped that the discussions of the conference will assist the Departments in advising Ministers on post-war flour and bread policy and in particular on any regulations which may have to be made after war-time control ends. The milling and baking industries, the flour importing trade and the co-operative movement have been asked to nominate representatives to the conference; invitations will be addressed to other interests later as may be necessary. The conference will be attended by the Lord Horder (personal adviser to the Minister of Food on medical aspects of food problems), Sir Jack Drummond (scientific adviser to the Ministry of Food), Sir Wilson Jameson (chief medical officer of the Ministry of Health), Dr. Andrew Davidson (chief medical officer for the Department of Health for Scotland) and Sir Edward Mellanby (secretary of the Medical Research Council). In addition, there will be present administrative officers representing the Ministry of Food, the Ministry of Agriculture and Fisheries and the Ministry of Health. Sir Henry French, the permanent secretary of the Ministry of Food, will be the chairman of the conference.

Agricultural Scholarships

THE Ministry of Agriculture and Fisheries invites applications for ten senior scholarships, tenable at university departments of agriculture, or agricultural colleges, for degree or diploma courses in an agricultural subject; or at veterinary colleges for courses in veterinary science; and for six extended junior scholarships (for those who have already held junior awards), and sixty junior scholarships, tenable at farm institutes or similar institutions, for courses not exceeding a year, in agriculture, horticulture, dairying or poultry husbandry. The scholarships are open to the sons and daughters of agricultural workmen or of working bailiffs, smallholders and other rural workers, and to persons who are themselves *bona fide* workers in agriculture. The value of the awards

is such that neither the recipients nor their parents are normally required to make any contribution towards the cost of the training provided. The usual method of selection is by interview. Full information concerning the scheme and forms of application may be obtained from the Secretary of the Ministry, Block 4, Bickenhall Mansions, Baker Street, London, W.1, or from the offices of County Councils. The latest date for submitting applications is April 30, 1945.

The Night Sky in April

New moon occurs on April 12d. 12h. 29m. U.T., and full moon on April 27d. 10h. 33m. The following conjunctions with the moon take place: April 9d. 19h., Mars 3° N.; April 17d. 13h., Saturn 0.1° N.; April 23d. 06h., Jupiter 3° S.; April 26d. 18h., Mercury 6.3° S. Only one occultation of a star brighter than magnitude 6 takes place in April, namely, 8 Leon., which disappears on April 21d. 1h. 29.7m. Mercury sets at 20h. 11m. at the beginning of April and rises at 4h. 10m. at the end of the month, about 25 minutes before sunrise. The planet is in inferior conjunction on April 13 and is stationary on April 3 and 25. Venus is a conspicuous object in the western sky in the early portion of the month, setting at 21h. on April 1. On April 30 the planet rises at 3h. 35m., an hour before sunrise. Venus is in inferior conjunction on April 15. Jupiter is visible throughout most of the night, setting at 5h. 13m. and 3h. 14m. at the beginning and end of the month, respectively. Saturn can be seen in the early portion of the night, setting at 1h. 49m. and just after midnight at the beginning and end of the month, respectively. The Lyrid meteors are active during April 18-22, but moonlight will interfere with the observation of the shower.

Announcements

WE regret to record the death on March 23 of Sir Napier Shaw, F.R.S., the doyen of British meteorologists, aged ninety-one.

BOTANISTS will be pleased to learn that Mr. E. J. H. Corner, assistant director of the Botanical Gardens, Singapore, who has been in the hands of the Japanese since the fall of Malaya is, according to a cable received from him, "well, happy, working as a botanist".

DR. THOMAS A. JAGGAR, the well-known volcanologist, has been awarded the Franklin L. Burr Prize of 1,000 dollars by the National Geographic Society. The Prize, established under a bequest of the late Mary C. Burr of Hartford, Connecticut, provides for cash prizes to members of the Society's expeditions considered to have done especially meritorious work in the field of geographical science. The award was made to Dr. Jaggar for his part in the development of an amphibian mobile boat in 1927, which was used by a National Geographic Society expedition headed by Dr. Jaggar to carry on researches in Alaska in the region of Pavlov Volcano during 1927-28.

A COURSE of twelve lectures in special librarianship has been arranged by the Association of Special Libraries and Information Bureaux, and will be held at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1, at weekly intervals starting on April 18, at 4.30 p.m. Applications to attend should be sent to the General Secretary, ASLIB, 52 Bloomsbury Street, W.C.1, as soon as possible; the fee is £5 5s. for the course.

LETTERS TO THE EDITORS

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

Age of the South African Ape-men

THE determination of the age of mammalian fossils of the later Tertiaries is a matter of the greatest difficulty. In America, Pliocene land beds are rather rare, and except in Europe where we can divide the Pleistocene by its Ice Ages, the classification of the Pleistocene is also very difficult. We have had many different views of the ages of the Siwalik deposits by Falconer, Lydekker, Pilgrim and Matthew. In South Africa we are in much greater difficulty as the majority of our mammalian fossils are not nearly related to those of Europe or Asia, and are even less related to those of America.

The determination of the age of the caves which have yielded the skulls and remains of the Australopithecines or ape-men is a matter of very great importance, as these Primate fossils show remarkable affinities to man. If they are Pleistocene they were contemporaries of man, though probably survivors from a family from which man arose in the Pliocene. If they are Pliocene they may be nearly related to the ancestor of man, and *Australopithecus* — the Taungs ape-man — may be so near to ancestral man as to be practically the 'missing link'.

At Kromdraai true horse (*Equus*) teeth are abundant. There is a large horse and a small one; so we may consider the Kromdraai ape-man *Paranthropus* as belonging to some part of the Pleistocene.

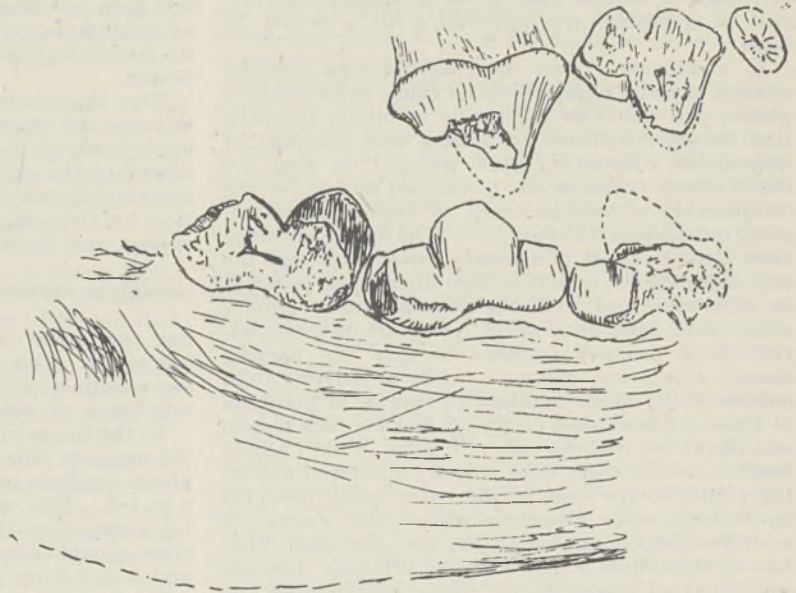
The Sterkfontein ape-man *Plesianthropus* is certainly of a very different age. No species of mammal is known from both Sterkfontein and Kromdraai except perhaps two species of the rats of the genera *Mystromys* and *Otomys*. The 'baboons' are different, the jackals are different, and so are the dassies. Further, no horse teeth are known from the Sterkfontein cave, though they have been found only 150 yards away. As a porcupine occurs which does not seem to differ from the living species, I thought it safer to keep *Plesianthropus* in the Pleistocene, though the presence in the cave of two species of sabre-tooth cats seemed to point to the deposit being old; but there was always the possibility of sabre-tooths surviving into Pleistocene in South Africa after they had died out in Europe and Asia.

The Taungs ape is manifestly much older than those others. The associated fauna is quite unlike that at Sterkfontein or Kromdraai. I, therefore, provisionally placed the Sterkfontein and the Kromdraai ape-men in Middle Pleistocene, and the Taungs ape-man in Lower Pleistocene, though not improbably belonging to Upper Pliocene.

I have just had given me a few days ago by the

Abbé Breuil the snout of a primitive hyæna. This was found by Dr. H. K. Silberberg at Sterkfontein three years ago. I have seen Dr. Silberberg and find that he picked up the specimen in the lower part of the Sterkfontein cave. The spot is almost directly below that in which the *Plesianthropus* type skull was found; but at about 60 ft. lower level. The fossils which I have collected at this lower level appear to be similar to those above.

We already knew a species of *Crocota* from Kromdraai very closely allied to the European *Crocota spelæa*, and from some part of Sterkfontein a jaw of *Hyæna hyæna*, and from the main Sterkfontein cave portions of a hyæna with the crowns of the teeth hopelessly broken. The hyæna discovered by Dr. Silberberg is a Pliocene type which must, I think, be placed in the genus *Lycyæna*. *Lycyæna* is a primitive genus found in the Lower and Middle Pliocene of Europe and India. While there is a possibility of the Pliocene *Hyæna* surviving into Pleistocene with the sabre-tooth cats, it now seems more likely that the Sterkfontein cave is Pliocene;



DENTITION OF *Lycyæna silberbergi* BROOM. NAT. SIZE.

and if so we must put the other caves to an earlier date also.

The Kromdraai skull we may put as probably Lower Pleistocene, and the Sterkfontein as probably Upper Pliocene. The Taungs skull, which must be much older, we may assign to the Lower part of the Upper Pliocene or even to Middle Pliocene. Of course, it will be readily understood that the difficulties are great, and the evidence very little. The director of the South African Geological Survey, Dr. A. W. Rogers, said in 1925 that "there was no probability of the age of the (Taungs) deposit being determined", and so far as I know no geologist has ever made any attempt to solve the difficulty. Still, some attempt must be made. So much hangs on it.

If the Taungs ape-man is of Pliocene, and possibly even Middle Pliocene, age it may again assert its claim to be very near to man's ancestor. Its teeth are practically identical with those of some Bushmen.

A full account of all we know of the South African ape-men has been prepared by Dr. G. W. H. Schepers and myself, and it is hoped that this work will be published this year.

R. BROOM.

Transvaal Museum,
Pretoria.
Jan. 27.

Index of Diversity as Applied to Ecological Problems

In Research Items in *Nature* of December 30, p. 833, attention is directed to Dr. C. B. Williams' recent paper¹ in which he applies the 'index of diversity' (α) to populations of various kinds. He claims that α is a property of the population, and is independent of sample size. He attempts to use it for the relation between numbers of species and size of sample in samples of plant populations obtained by means of quadrats, and in using some figures of Gleason's implies that, given a random distribution of quadrats, the application of α would be valid.

It is difficult to test these assumptions directly, since it is usually impossible to count individuals of plants, and therefore impossible to obtain the relation between numbers of species and numbers of individuals. Recently, while engaged on work for the Forestry Commission, I obtained figures for the composition of various kinds of heath vegetation, using quadrats of different sizes. The figures obtained show that the index of diversity varied both with the way in which the quadrats were distributed (random or otherwise) and with the quadrat size. Thus α obtained by using quadrats of 1/8 square metre (quadrats being grouped together to give the varying sample sizes) was about 7, while α derived from counts of the mean numbers of species in quadrats of three different sizes (1/20, 1/8 and 1 square metre) was about 1.2. In the case of a piece of old *Calluna* heath in which there were only six species of flowering plant, 76 per cent of the cover being provided by *Calluna*, while *Empetrum nigrum* and *Vaccinium myrtillus* formed the remainder, the calculated number of individuals expected from Williams' formula was 3,000 per square metre. The actual number was not recorded, but the calculated number is obviously absurd.

Thus the index of diversity is apparently not applicable to numbers of plant species present in quadrats. The reason would seem to be that the formula takes no account of the amount of space occupied by the individual. In the insect populations first studied by Williams, sample size was defined by number of individuals—a fundamentally different method of sampling from that of taking quadrats, in which sample size is defined by area. The method of sampling an insect population comparable to taking a quadrat would be to take all the insects present in a given volume of space at any instant. While Williams' formula and the index of diversity derived from it may be valuable in some cases, it appears that the theoretical basis of its application needs further study.

E. W. JONES.

Imperial Forestry Institute,
Oxford.

I HAVE read with interest Mr. Jones's letter on the results of the application of the logarithmic series and the index of diversity to his quadrat observations. I completely agree with him that the theoretical basis requires further study; as also does the field application to both animals and plants. The object of my publication, which gave a few cases selected over a wide field, was to stimulate the production of new data whether in support of the theory or not.

The essential difference between sampling in insects based on numbers and in plants based on area was emphasized by me both in the paper quoted and in an article in *Nature*¹. The application to botanical problems of a theory based on numbers of individuals was justified on the assumption that within one ecological formation the number of individuals could usually be considered as proportional to the area. This is only true if the size of the area sampled is large enough to contain a fair sample of the vegetation. In spite of this difficulty, I was surprised to find that in the sets of data that I collected almost at random from botanical literature, the results were consistent with the logarithmic series, and gave not unreasonable estimates of the numbers of individuals on a quadrat. If Mr. Jones's figures do not so fit, then it will be interesting to find the reason.

Even in animals, however, it is not always necessary to know the exact number of individuals in order to apply many of the general principles of the log series, including the index of diversity. For example, if two random samples of insects from the same population by the same method give x individuals of 40 species and $3x$ individuals of 60 species, then it is

possible to say that $\alpha = \frac{60-40}{\log_2 3} = 18.2$, without know-

ing the value of x , except that it must not be too small. This very closely resembles the case of two quadrats of size 1 and 3 units with an unknown number x of individuals on each unit area.

In the limits of a letter, Mr. Jones cannot give all the essential data, but I will take first his statement about quadrats of 1/20, 1/8 and 1 square metre giving $\alpha = 1.2$. This would suggest, on the basis of the log² series, that if there were x species on 1/8 sq. m. there should be approximately $x - 1.1$ on 1/20 sq. m. and $x + 2.5$ on 1 sq. m. ($x - \alpha \log_2 2.5$, and $x + \alpha \log_2 8$). On the other hand, his data for several quadrats of 1/8 sq. m. on the same area giving $\alpha = 7$ would imply that if there were x species on 1/8 metre, there would be about $x + 14.5$ on $8 \times 1/8$ sq. metres; in other words, that eight separated quadrats of 1/8 sq. metre gave 12 species more than 1 sq. metre in a block. I suggest that the obvious explanation is that there was a strong aggregation of plants of each species in groups. When this is occurring, there will be very great differences between single small quadrats both in number of species and number of individuals, and one would not expect conformity with the log series unless the size of the sample was considerably increased. It is pointed out in the paper quoted that the application of the log series to quadrats is only justified if the number of individuals in the quadrat is large compared with α . In the locality studied by Mr. Jones it seems likely that an area of 1/20 m., with plants as large as *Calluna*, might easily contain only one or two individuals.

Whether or not the whole conception of the log series could be extended to allow for aggregation, that is, to include a measure of it, I do not know,

¹ *J. Ecol.*, 32, 1 (1944).

but it is an interesting possibility. For the moment, I think it is better to say that with extensive aggregation the size of the sample must be increased.

I trust that I have done justice to Mr. Jones's remarks, without having access to his data.

C. B. WILLIAMS.

Rothamsted Experimental Station,
Harpندن, Herts.

¹ *Nature*, 152, 264 (1943).

Colour Vision of the Fovea Centralis

I HAVE read with great interest the letters of Drs. Stiles, Thomson and Pirenne in *Nature* of February 10, in which among other things König's early work is mentioned. Some experiments to be described below indicate, I think, that the factors involved are more complicated than has previously been supposed. Mr. Willmer is under the impression that it is only the fovea centralis that suffers from some form of dichromatism. I find, on the contrary, that it is a considerable area of the retina which is affected at times by this defect; all that has to be done to make the greater part of the retina appear dichromatic is sufficiently to reduce the visual angle of the test object.

When König investigated the colour vision of his fovea centralis, and found dichromatism there, he found he had to preserve very strict central fixation, since small deflexions of the eye axes caused the true colours of the test objects to be perceived. Mr. Willmer¹ found a similar state of affairs: "If the eye is focused not on the centre of the circle (circular test object) directly but on the point A, about 4 cm. from the centre of the circle, then all the quadrants stand out in their true colours". Now, I do not find this, and neither does my observer, G. W. J. In our cases, if the test object is small enough to cause dichromatic vision on the fovea centralis, then it is also small enough to cause similar dichromatism on whatever part of the useful retina the image falls.

Clearly there is here a marked difference of observation. But there is another difference even more marked which must be alluded to. Mr. Willmer used as his test object a circle 2 cm. in diameter, which was divided into quadrants. He found that the colours of these quadrants became modified when the test object was viewed with one eye from a distance of about 3 metres. I have myself used his test objects, which he very kindly placed at my disposal for the purpose, and I found that I required a much greater distance than 3 metres for dichromatism to show itself.

The test object I have been employing consists of a bright yellow square, the dye used being a saturated solution of picric acid in water. If the square had 1 cm. sides, the distance required to exhibit dichromatism, by the square becoming white, would be approximately 16 metres. It would seem from these facts that my fovea centralis is more 'resistant' to dichromatism than Mr. Willmer's in the sense that the test object has to be reduced in size much more for me than it has for him.

Two of my observers, E. C. T. and J. E. T., obtained substantially similar results to myself; on the other hand, two other observers, J. L. de S. and G. N. J., approximate more to Mr. Willmer in their experimental findings. It is clear that observers differ in detail, but in this important particular they are all alike: all find that dichromatism is

not a property of the fovea centralis alone, but is present also in the more peripheral parts of the retina. The following example brings out this point clearly.

The observer G. W. J. found that his fovea centralis was trichromatic when the distance of the test object was 3 metres from his eye. It was dichromatic when the distance was 4 metres. The demarcation between the two types of vision occurred at about 3.6 metres. When a fixation point 4 cm. to one side of the test object was fixated, trichromatism was found at 3 metres, dichromatism at 4 metres, the transition between the two types of vision occurring at 3.3 metres. When the fixation point was 8 cm., the distance in each case is somewhat less, and the transition occurred at 2.9 metres.

It is relatively easy to explain a dichromatism which affects a limited portion of the retina such as the fovea centralis. One can suppose, as Mr. Willmer has done, that an essential sensory structure such as that responsible for the blue sensation is absent from this region. It is much more difficult to explain a dichromatism which appears sometimes and not at others throughout a large area of the retina, and seems to vary according to the size and distance of the test object.

An attractive hypothesis would be: when objects produce on the retina images smaller than a certain size, the blue receptors which are stimulated become so few in number that their impressions fail to get through to consciousness. I find, however, that this supposition is contrary to the observed facts. If the process taking place was one of blue blindness, then one would expect white objects to appear yellow, since this is the combined result of stimulating the remaining red and green receptors. But such is definitely not the case, for we do not find that white becomes yellow; quite the contrary, it is yellow which becomes white.

In support of the contention that the dichromatism is not caused by blue blindness, the following experiment may be quoted. The observer takes up a position in respect of a yellow test object at which it is just beginning to be confused with a white test object of the same shape and size. He now places a deep blue filter in front of his eyes and looks at the brightly lit sky for several minutes. Having reduced the sensitiveness of his blue receptors by this technique, he suddenly removes the filter from his eyes and without delay critically examines the yellow and white test objects. He finds both of them to be a brilliant yellow; in other words, he gets a result which is entirely different from that produced by a reduction of the size of the test object. Whereas inhibiting more or less completely the blue receptors causes white to become yellow, the dichromatism produced as a result of reducing the size of the test object causes yellow to appear white.

When test objects having colours other than yellow are investigated, it will be found that the following changes occur: red and orange remain unchanged; yellow, yellow-green and green have blue added to them; blue-green remains unchanged; blue, violet, mauve and crimson have blue subtracted from them.

It seems that the addition of blue to some colours and its subtraction from others points to the existence of quite a complicated mechanism which sharply differentiates the colours. This mechanism may depend on the brightness of the colours, since yellow, yellow-green and green are relatively bright colours, whereas blue, violet, mauve and crimson are relatively

dark ones. The fact that blue is added to some colours and subtracted from others accounts, I think, for the fact that white remains unaltered.

Further experiments are in progress in order to determine more exactly the nature of the colour change, and the means by which it is brought about.

I should like to thank J. E. T., J. L. de S., G. N. J. and E. C. T. for the trouble they have taken in acting as observers for me.

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Feb. 13.

¹ *Nature*, 153, 774 (1944).

Nutritive Value of Coconut

IN NATURE of September 30, 1944, p. 437 occurs the statement: "and from these accounts it appears that babies fed entirely on coco-nut prepared in various ways until they are more than eighteen months old may be as healthy as those that are breast-fed".

The kernel of the coconut contains 35-45 per cent of oil, about 15 per cent of carbohydrates and a little less than 5 per cent of proteins of low biological value for infants. The kernel is very indigestible for adults and more so for infants when taken in large amounts, because of the great quantity of fibrous matter it contains.

The commonest preparation in the diets of those who consume much of this nut is 'coconut milk'. This is prepared by kneading grated coconut into two or three lots of water and mixing them together; the emulsion thus formed has much the appearance of cow's milk.

The analysis of coconut milk shows that the greater part of the oil has gone into emulsion with some of the protein and carbohydrates, and the residue of the grated nut contains all the cellulose and other indigestible matter of the kernel. It must be in this form, perhaps after mild fermentation, that coconut is given to infants. Supposing an ounce of grated coconut is used to prepare two ounces of milk, then the milk will contain less than 0.5 gm. of protein, about 5 gm. of fat and 1.5 gm. of carbohydrates per oz.; there will be about as much sodium chloride and about half as much calcium as in human milk. Coconut is notoriously deficient in vitamins, and the milk contains a little thiamine, probably enough to deal with the metabolites from the small amount of carbohydrates in the milk; but there are only traces of carotene and ascorbic acid.

Undoubtedly biological adaptations have taken place, whereby some races are able to digest and find ample sustenance in foodstuffs which would not bring health and longevity to peoples of some other races. Probably coconut milk can supplement human milk to a small extent. It is, however, difficult to believe that the infants of any race can be weaned and thrive for a year or more on an oily diet deficient in proteins and calcium and containing only traces of vitamin A (carotene) and ascorbic acid.

Statements concerning native diets in many parts of the world are often at variance with our newer knowledge of nutrition; very little knowledge exists

of the dietary habits of the races of the world. There is an urgent need for dietary surveys to be carried out by scientific workers well acquainted with the difficulties of the subject. Such surveys will be of the greatest importance to supplement and perhaps modify some of the present views on human nutrition founded to a great extent on animal experiments. But all such surveys must be accompanied by surveys of the growth and state of nutrition of all classes among each people.

LUCIUS NICHOLLS.

THE term 'coconut milk' is usually applied to the fluid contained in the centre of the nut. It seems to have a very low nutritional value, containing only about 0.4 per cent of protein; 5 per cent of carbohydrate and a negligible vitamin and calcium content. Its calorific value is only about 20 per 100 gm.

The flesh of the fresh coconut, on the other hand, contains, according to the figures I have by me, a little more than 4 per cent of protein, which is certainly of poor biological value; about 39 per cent of fat and rather less than 9 per cent of carbohydrate, giving the relatively high calorie value of 400 per 100 gm. The calcium and iron contents are low. The only vitamin analyses I have for the flesh of the fresh fruit show a very small vitamin B₁ content of 0.03 mgm. per 100 gm. and about 2 mgm. of ascorbic acid per 100 gm. Vitamin A, either preformed or as carotene, is almost certainly absent.

Broadly speaking, therefore, the criticisms contained in Dr. Nicholls' letter can be sustained.

J. C. DRUMMOND.

Linoleic Acid, α -Tocopherol and Other Fat-Soluble Substances as Nutritional Factors for Insects

It is now well established that, for growth, insects require a sterol in the diet. We have now established the need for other fat-soluble factors in experiments on the nutrition of a number of insects. Thus the caterpillars of *Ephesia kuehniella* grow very badly on an artificial diet consisting of casein, glucose, yeast, cholesterol, salt mixture and water. A few reach the pupal stage after a long time, but moths invariably fail to emerge. With *Ephesia elutella*, growth is relatively better on such a diet; but again, the moth fails to emerge. This deficiency is entirely overcome by adding wheat germ oil in quantities of approximately $\frac{1}{2}$ -1 per cent of the diet.

We have saponified wheat germ oil and tested the two resulting fractions (saponifiable and unsaponifiable) separately and combined. With both these fractions growth is as good, or almost as good, as with wheat germ oil. With the saponifiable fraction alone, *Ephesia kuehniella* still grows rather slowly, but those which reach the pupal stage ultimately emerge as normal moths. With *E. elutella* growth is almost as good as with wheat germ oil; and emergence is normal. In the presence of the unsaponifiable fraction alone both species grow very badly, and the few moths formed never emerge. Thus it appears that *Ephesia kuehniella* requires two factors contained in wheat germ oil, one saponifiable and the other unsaponifiable, while *E. elutella* probably requires only the saponifiable factor.

Further tests have made it beyond doubt that the saponifiable factor is linoleic acid. With linoleic acid and the unsaponifiable fraction, the moths of *E.*

elutella and *kuehniella* always emerge. If linoleic acid is added to the diets in insufficient quantities moths emerge, but are incompletely developed and the wings are partly or entirely lacking in scales. By adding graded doses of linoleic acid to the diet, all transitional stages between failure to emerge and normal moths can be produced; namely, deformed moths with naked wings, normal moths with naked wings or with wings more or less patchy. The same result has been obtained with graded doses of wheat germ oil. Imperfect moths are also formed when the diet contains oils poor in linoleic acid, such as coconut oil, allenblackia oil or lard.

The unsaponifiable factor in wheat germ oil which is required by *E. kuehniella* is almost certainly vitamin E. A diet which contains the saponifiable fraction of wheat germ oil or linoleic acid is greatly improved by the addition of pure α -tocopherol, in some cases even more than by the addition of the unsaponifiable fraction. There are, however, indications that the favourable effect of vitamin E is not specific. Lard, which is considered to be lacking in vitamin E, certainly contains something as efficient as the unsaponifiable fraction of wheat germ oil, if not more so. Finally, we have succeeded in demonstrating that ethyl- or propyl-gallates have an effect the same as, or similar to, vitamin E. This would suggest that the effect of the unsaponifiable factor is not a specific one, but that of an antioxidant which stabilizes linoleic acid.

There are, however, indications that linoleic acid plus a suitable antioxidant are not the only factors of importance concerned in this reaction. If it were merely a matter of having sufficient linoleic acid in the diet and having it efficiently stabilized, one would expect that growth-rate and degree of scaliness of the wings would go together, so that the growth-rate would always be high where the moths are normal, and always low where the wings are scaleless or patchy. This, in fact, is not the case. With the saponifiable fraction alone, growth of *E. kuehniella* is slow, but the moths are perfect; while with lard, growth is fast but the wings are imperfect. This suggests that a third factor must be involved in the reaction.

The consequences of a lack of linoleic acid, namely, failure to emerge, or emergence of moths with the scales missing to a greater or lesser extent, are different expressions of the same condition. The moth inside the pupal skin seems to develop normally until emergence, with the scales formed on the wings. When the moth emerges, the missing scales are always found on the inside of the cast exuvia. In the extreme case, the scales seem to stick firmly to the pupal case not only in the region of the wings but also elsewhere, notably the abdomen, so that emergence is impossible. This shows that a failure of the scales of the moth to separate from the pupal skin is the cause of the abnormal condition; this may be due to failure to excrete sufficient moulting fluid. It is interesting to note that the condition of incomplete wings which arises from a lack of linoleic acid is similar in appearance, if not perhaps identical, to a genetical aberration in *Ephestia kuehniella* described by Kühn and Henke¹ under the term "Glasflügeligkeit". This perhaps suggests that the physiological action of this particular gene is concerned with the linoleic acid metabolism.

We have so far not succeeded in demonstrating the need for linoleic acid, vitamin E or other fat-soluble factors which are contained in wheat germ

oil in insects other than those belonging to the genus *Ephestia* (*E. cautella* as well as *kuehniella* and *elutella*). The very closely related species *Plodia interpunctella* certainly does not require linoleic acid, and probably none of the other factors. Other insects which we have tested, including about ten species of beetles and moths, do not seem to be in need of any fat-soluble factors in addition to sterols, and this agrees well with recent work on the dietetics of insects which has been conducted in other laboratories.

G. FRAENKEL.

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Jan. 26.

¹ Kühn, A., and Henke, K., *Abh. Ges. Wiss. Göttingen, Math. Phys. Kl., N.F.*, 15, 1 (1929).

Acaricidal Property of a New Insecticide, Hexachlorobenzene

FOLLOWING closely on the several recent demonstrations of the considerable insecticidal potency of 'D.D.T.' (dichloro-diphenyl-trichlorethane) it is surprising to find another substance which, on preliminary trial, promises to be at least as good, and in some ways even better than, 'D.D.T.'. Through the courtesy of Imperial Chemical Industries, Ltd., I have recently had the opportunity of carrying out a few trials with a substance temporarily designated '666' which has been recognized for some little time by I.C.I. research workers as possessing unusually active insecticidal properties. This substance, which may now openly be referred to as hexachlorobenzene, has the general formula $C_6H_2Cl_6$ and is a very remarkable compound in that the extraordinary insecticidal properties are held solely by the γ isomer. It is understood, however, that a general statement is shortly to be made by those who have been engaged in the development of this substance as an insecticide, when details on that interesting point will be published.

A few tests recently carried out at this Laboratory on the action of hexachlorobenzene on guinea pig lice showed it to be at least as effective as D.D.T. It was also found to be exceedingly toxic to the freshwater crustaceans, *Cyclops*, *Daphnia* and particularly to *Diaptomus*; but in whatever other direction this new substance may excel, its action on parasitic acari promises to be one of the most potent, as was indicated by comparative trials carried out on rats severely affected by notoedric mange. In these trials a comparison was drawn between the efficacy of 1 per cent solutions in liquid paraffin, or olive oil, of hexachlorobenzene, benzyl benzoate, tetraethylthiuram-monosulphide ('Tetmosol') and 'D.D.T.'. Of these four substances hexachlorobenzene was found to be much the most active, and, apparently, without any danger to the treated animals. 'D.D.T.', on the other hand, showed very little effect, and in a second series of trials, when used in 2 per cent strength, led to the death of some of the experimental rats after the development of marked hyperaesthesia and frequent clonic muscular spasms.

A preliminary cleansing of the affected parts of the rats with soap and water was not carried out in these tests, nor was the whole surface of the body treated with the dressings, which were applied only to the affected (hairless) parts. As complete cure

was brought about under these relatively difficult conditions, and living mites were not found in the old lesions, it is thought that in all probability hexachlorobenzene will ultimately prove to be of great value in the treatment of psoroptic scabies (including 'sheep scab') in animals, and of sarcoptic scabies in animals, and also in man.

E. L. TAYLOR.

Veterinary Laboratory,
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Weybridge. Feb. 7.

'D.D.T.' as a Sheep Blowfly Dip

THE powerful toxic action of 'D.D.T.' on many species of flies has made possible a new method of attack against the sheep blowfly *Lucilia sericata* (Mg) and related species. As the following experiments indicate, control may be achieved by the direct action of a 'D.D.T.' dip on the blowfly while the insect is searching the fleece for a site suitable for egg-laying.

The preliminary laboratory experiments were made by Dr. E. T. Burt of the Unit of Insect Physiology (Agricultural Research Council), who showed that sheep wool dipped in an emulsion containing 0.5 per cent 'D.D.T.' was toxic to laboratory-bred specimens of *L. sericata*. The following field tests gave results in keeping with this observation and demonstrated that the toxic effect could take place rapidly enough to prevent gravid females of *L. sericata* from ovipositing on sheep.

Two dipping trials were made on farm flocks consisting mainly of Welsh mountain sheep. In both cases the same dipping procedure was adopted and the same 'D.D.T.' emulsion (M 21) used.

In the first trial eighty-one sheep were dipped, the concentration of the bath falling from 0.3786 to 0.3264 per cent 'D.D.T.' in the course of the dipping. The sheep remained free from strike throughout the period of the experiment, August 8–September 18, a total of forty-two days. It was not possible to have a control group grazing with the experimental flock; but chemotropic experiments made on this particular farm indicated that conditions for strike were better in August and September than in the four weeks prior to dipping, when ten strikes were recorded in the flock. Further, bad cases of maggoting were reported on neighbouring flocks.

The second trial comprised a total of 430 sheep grazing on five different regions of one farm. Each grazing unit was divided into two equal groups as regards breed, age and sex. One group was dipped with the 'D.D.T.' emulsion and the other with a commercial arsenical dip. The 'D.D.T.' concentration fell from 0.4540 per cent to 0.2388 per cent in the course of the dipping.

The experiment lasted from August 29 to October 13, a period of forty-four days. Three strikes occurred on 'D.D.T.'-dipped sheep; one of these was a re-strike. Twenty-one strikes occurred in the control group which had been dipped with the commercial preparation; no re-strikes were recorded in this group. In the control group the first strike occurred six days after dipping and in the 'D.D.T.' group twenty-four days after dipping, by which time thirteen strikes had been recorded on the controls.

The following experiments clearly show that the effectiveness of the dip lay in its direct action on the blowfly.

Three weeks after dipping, specimens of *L. sericata* were captured from undipped and 'D.D.T.'-dipped sheep. Of twenty-five flies caught on the undipped sheep, two died in twenty-four hours. Of thirteen caught on the 'D.D.T.' group, nine died in twenty-four hours. All the flies which died, including those caught on the control group, showed symptoms of 'D.D.T.' poisoning within 15–30 minutes of capture. A similar test five weeks after dipping showed one death out of sixteen flies captured on the controls and five out of sixteen captured on the 'D.D.T.' group.

Tests in which gravid females of *L. sericata* were kept in contact with the fleece of a 'D.D.T.'-dipped sheep showed that even five weeks after dipping, 30–60 seconds contact was sufficient to have a toxic effect on the flies.

The action of the dip in preventing oviposition was clearly demonstrated by tests with artificial attractants. The Hobson¹ technique was employed, and five 'D.D.T.'-dipped with five undipped sheep were used in each experiment.

NUMBER OF EGG BATCHES LAID IN REGION OF ATTRACTANT.

Date 1944	No. of days after dipping	Sheep dipped with 'D.D.T.'	Control group undipped
Aug. 8	0	No test	
" 10	2	0 0 0 0 0	2 1 3 1 1
" 15	7	0* 0 0 0 0	0 2 2 1 0
" 23	15	0 0* 0 0 0*	4 3 8 7 3
" 30	22	0 0 0 0 0*	3 0 2 - -
Sept. 7–11		Weather conditions not suitable for tests	
" 12	34	0 0 0* 0 0*	3 2 - - -
" 19	41	0 0* 0 0 0	Controls not available
" 21	43	0 0 0 0 0	3† 2† 0† 0† 0†

* From 3–6 scattered eggs laid, except in the case on September 19, when 15 eggs were found.

† The sheep used as controls on September 21 had been dipped with a proprietary arsenic dip on September 19.

The accompanying table summarizes the results obtained. On no occasion was a complete and compact batch of eggs laid on the 'D.D.T.'-dipped sheep, whereas oviposition was invariably induced on the control group. The results obtained on September 21 are of particular interest because the control group had been dipped with a proprietary arsenic dip only two days previously and their fleeces were sticky and had a strong odour; yet oviposition occurred on them but not on the sheep which had been dipped with 'D.D.T.' some six weeks previously.

In the course of the 1945 blowfly season, the dip is to be given extensive field trials and attempts are to be made to increase its effectiveness by combining an attractant with it, thus making the dipped sheep act as blowfly traps.

I wish to thank Mr. L. Davies for assistance with the field experiments and Dr. J. G. Mitchell of the D.S.I.R. Chemical Laboratory for the preparation of the 'D.D.T.' emulsion and for determining the 'D.D.T.' concentrations mentioned above.

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University College of North Wales,
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¹ Hobson, R. P., *Ann. Appl. Biol.*, 24, 627 (1937).

Hydrogen Sulphide Gas as a Preventive of Putrefaction

In a collection of old microscope slides recently re-examined, a series came to light illustrative of observations made by me some twelve years ago and not hitherto published. They are perhaps of sufficient interest to be put on record now.

During the course of work on the sterilization of dried hides from anthrax¹, the lines of which were suggested by observations by Andrjewski², on the toxicity of hydrogen sulphide for anthrax spores, it was found that anthrax spores could be killed by exposure in anaerobic jars to an atmosphere of this gas.

To find out whether hydrogen sulphide was toxic in the same conditions to other micro-organisms and might therefore delay or prevent putrefactive changes, the following experiment was done. Pieces of raw hide newly removed from the animal were put in anaerobic jars—either suspended or laid in petri dishes. The air in the jars was then exhausted by means of a vacuum pump and hydrogen sulphide run in from a kip—being passed first over 1 per cent caustic soda to remove any trace of hydrochloric acid that might be present. The jars were allowed to stand at room temperature or at 37° C. Cuttings from the samples under treatment were taken at intervals, sectioned, stained and compared with cuttings from the same hide kept in air in similar jars at the same temperatures. The hydrogen sulphide jars were refilled at once with the gas after each time of opening.

It was found that in the pieces kept in an atmosphere of hydrogen sulphide, putrefaction was almost entirely checked for a period of at least a week at 37° C. and a month at (approximately) 20° C. One hydrogen sulphide jar was kept sealed (and forgotten) for eight years. At the end of that time the sample of hide was still moist and sufficiently intact to be sectioned, and though the epidermis and cellular structures in general had disappeared and there was considerable breakdown of the fibre bundles, the main outlines of the hide structure were still traceable.



Fig. 1.

Fig. 2.

Fig. 1. OX HIDE KEPT FOR THREE DAYS IN AIR AT 37° C. IN A SEALED JAR.

The epidermis and all the other cellular structures (sebaceous and sweat glands, linings of hair follicles and interstitial cells) have disappeared. The fibre bundles are loosely woven and are showing signs of breakdown.

Fig. 2. OX HIDE KEPT FOR SEVEN DAYS AT 37° C. IN HYDROGEN SULPHIDE IN A SEALED JAR.

The epidermis and other cellular structures are intact or practically so. The fibre bundles are compactly woven and show little or no sign of degeneration.

The accompanying photomicrographs illustrate the condition of the air-treated sample after three days at 37° C. and of that treated with hydrogen sulphide after seven days at the same temperature.

Unfortunately the section shown in Fig. 1 was cut in the direction of the hair follicles and that shown in Fig. 2 across their main direction. In spite of this, however, the much better state of preservation of the sample shown in Fig. 2 is obvious.

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Feb. 13.

¹ Robertson, *J. Hyg.*, 32, 367 (1932).

² Andrjewski, *Amer. J. Bact.*, 16, 151 (1928).

Vernalization of Rice by Short Days

In a previous communication¹, the effectiveness of the method of vernalization of rice by short days has been reported. The method has been tried further with several varieties of rice grown in Bengal, and interesting results of agricultural importance in one winter variety, 'Rupsail', have been noted.

Flowering duration of this variety has been reduced from 133 to 47 days by this method. So far as we are aware, flowering of winter varieties of rice within such a short period has not been reported previously. By applying short days to several varieties of rice, Alam² came to the conclusion that all varieties require a minimum period of 30 days for vegetative growth and a succeeding period of about 30 days of short-day treatment for coming into flower.

This acceleration of flowering has great possibilities for the cultivation of rice in Bengal. First, a variety of fine rice could be grown in a much shorter time; secondly, by inducing early maturity, it could escape flood; and thirdly, early harvesting would leave sufficient time for the preparation of fields for the crops following in rotation.

A full report of this work will be published elsewhere. We wish to express our thanks to Prof. S. P. Agharkar for encouragement and facilities to carry out this investigation.

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B. PARIJA.

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Nov. 7.

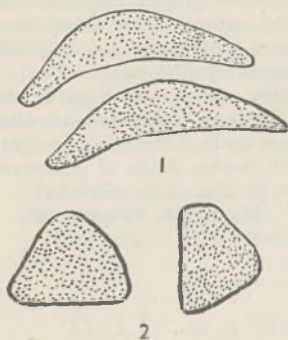
¹ *Nature*, 153, 378 (1944).

² See *Sci. Rep. Rice Res. Stat.*, Sabour, Bihar (India), 1940-41.

Two New Records of *Sphacelia* from Mysore

In the course of his studies on the sugary disease of *Sorghum vulgare* caused by *Sphacelia Sorghi* McRae, Ajrekar¹ recorded three other wild grasses, namely, *Andropogon caricosus* var. *mollicomous*, *Ischaemum pilosum* and *Pennisetum alepecurus* as having the *Sphacelial* stages of an ergot. Sclerotial stages were observed by him only on the last-named host, and he pointed out that heavy infestation by a species of *Cerebella* competed with the formation of sclerotial stages in other cases.

Collections of ergot on wild grasses in Mysore I have made included *Sphacelial* and sclerotial stages



1. SPORES OF *Sphacelia* on *Brachiaria distachya*. 2. SPORES OF *Sphacelia* ON *Amphilophis pertusa*. $\times 1800$.

tion, which at first is translucent, later on hardening into a whitish crust associated with saprophytic yeast cells. Numerous oblong-ovate spores (which are slightly arcuate and slightly pointed at the tips) of the *Sphacelia* become embedded in the nectar. The spores measure $12.6-19 \times 3.8-6.3 \mu$. Subglobose to spherical sclerotia are formed only in a few cases unaffected by *Cerebella*. In the absence of germination stages of the sclerotia, the identity of the *Claviceps* species remains obscure.

The Sphacelial stages on *Amphilophis pertusa* are also restricted to individual florets. Partial development of sclerotia due to infestation of *Cerebella* have been observed in some cases. The conidiospores are numerous, hyaline, borne on conidiophores developed as a felt on the surface of the ovary. The spores are distinctly triangular, somewhat rounded at the ends, measuring $8.8-11.4 \times 6.3-7.7 \mu$. Such a type of triangular spores is at variance with the *Sphacelia* of *Claviceps* species recorded both on members of Gramineae and Cyperaceae. On account of the differences in size and shape of the spores, the name *Sphacelia Amphilophidis* is tentatively proposed for the accommodation of the fungus. Detailed description and diagnosis of the species are being published separately.

Grateful thanks are due to Dr. L. N. Rao, professor of botany, University of Mysore, for kind encouragement.

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¹ Ajrekar, S. L., *J. Ind. Bot. Soc.*, 5, 55 (1926).

Scattering of Light in Crystals

SINCE its discovery¹, early in 1928, the scattering of light with altered frequency has been investigated in many crystals, and much valuable information has been accumulated. The significance of the results and their relation to theories of the solid state are clearly matters of great interest.

The outstanding result of the experimental studies is that the atomic vibration spectrum of crystals in the infra-red region reveals itself in light-scattering as a set of discrete frequencies, the approach to monochromatism being the more complete the more perfect the crystal, and the lower the temperature at which it is studied. It is particularly significant

that this feature obtains not only in respect of the so-called internal vibrations of the ions or molecules comprised in the crystal, but also in respect of their translatory and rotatory oscillations which are characteristic of the crystalline state. As a typical case, calcite may be mentioned. Dr. R. S. Krishnan has recorded extremely intense spectra with this crystal employing the 2537 A. radiations of a water-cooled, magnet-controlled quartz mercury arc as the exciter and giving prolonged exposures. Besides the internal vibrations of the CO_3^{2-} ions and their translational and rotational oscillations, octaves and combinations of these frequencies are also found recorded in the spectrum. All of them appear as sharp lines, but not a trace of continuous spectrum is noticeable on the plates.

Comparative studies with various substances in the molten and solid states make it clear that every mode of infra-red vibration which gives rise to appreciable variations of optical polarizability in the volume elements of a crystal also manifests itself as a frequency-shift. Hence, as in the cases of gases and liquids, we are entitled to infer that the spectrum of light-scattering in a crystal is a faithful map of the fundamental infra-red vibration spectrum, excepting only the modes for which the symmetry excludes any variation of optical polarizability.

Recently, by a straightforward dynamical investigation², I have shown that the fundamental vibration spectrum of a crystal containing p sets of non-equivalent atoms consists of the $(3p-3)$ modes which repeat themselves in adjacent cells of the Bravais lattice, and in addition $21p$ other modes in which the phase alternates in successive cells. The prediction confidently made that these $21p$ modes should also manifest themselves in light-scattering has been strikingly confirmed by Dr. R. S. Krishnan³ in the case of diamond.

It is clearly impossible to reconcile the facts stated above with the theories of the solid state which assume, or claim to show, that the atomic vibration spectrum of a crystal in the infra-red region is a continuous one. To effect any such reconciliation, it would be necessary to invent a mechanism which could transform the assumed continuous spectrum of frequencies into a discrete line spectrum by a process of exclusion. One such mechanism which has often been suggested is that the phases of the infra-red vibration are perfectly coherent over the whole volume of the crystal, in consequence of which all the scattered radiations disappear by optical interference except those arising from the so-called limiting modes of vibration, $(3p-3)$ in number, the phase wave-lengths of which are comparable with the length of the light waves and satisfy the Bragg condition for reflexion. To this suggestion, however, there is a fatal objection, namely, that $21p$ other modes which have much smaller phase wave-lengths not satisfying this condition are also observed in light-scattering, while the infinitely numerous others which are also assumed to exist in the aforesaid theories fail to manifest themselves. A further objection is that, in actual crystals, the assumed coherence of phase can scarcely be expected to extend over sufficiently great volumes for optical interference to be effective. For the latter reason, the continuous spectrum assumed to exist in such theories should manifest itself fully in light-scattering or at least give an observable indication of its existence. Since this is not the case, we can only infer that the postulated continuum does

not exist in the infra-red region of frequency. We are, of course, here not discussing the low-frequency or elastic solid vibrations in which the discrete atomic structure is not explicitly involved.

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Feb. 14.

¹ Raman, C. V., *Ind. J. Physics* (1928).

² Raman, C. V., *Proc. Ind. Acad. Sci.*, A, 18, 237 (1943).

³ Krishnan, R. S., *Proc. Ind. Acad. Sci.*, A, 19, 216 (1944).

X-Ray Crystallography of Kojic Acid

At a time when its identity was uncertain, specimens of the compound isolated by M. A. Jennings and T. I. Williams¹ from *Aspergillus effusus* were examined in order to determine its molecular weight. The compound was later shown to be kojic acid. It forms monoclinic needles elongated along [100] and showing the forms {100}, {010} and {021}. The following data for the unit cell were obtained from X-ray oscillation photographs: $a = 3.85$, $b = 18.4$, $c = 8.84$ Å.; $\beta = 74^\circ$, correct to about ± 1 per cent.

Absent spectra indicate that the space group is $P 2_1/c$ and the density determined by flotation in an ethylene dibromide-bromobenzene mixture is 1.559 ± 0.006 . The space group allows any even number of molecules in the cell, and if four molecules are assumed the molecular weight is 142 ± 3 . This value is in good agreement with the formula $C_6H_6O_4$ (mol. wt. 142) and with the quantitative analysis and cryoscopic determination of F. Traetta-Mosca².

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¹ *Nature*, 155, 302 (1945).

² *Ann. Chim. Applicata*, 1, 477 (1914).

Long Duration of the Balmer Spectrum in Excited Hydrogen

LORD RAYLEIGH has reported recently¹ the results of a new experimental determination of the duration of the emission of hydrogen Balmer lines, H_α , H_β and H_γ . Hydrogen (pressure 0.2 mm. mercury) was excited by an electrodeless discharge in a tube having the form of a square ring connected with a side tube, through which it was exhausted. Each discharge (of very short duration) produced a luminous jet squirting out of the discharge space, along the tube. The light emitted by the jet contained the Balmer lines in question. From the measurements of the speed of the jet (by means of a revolving mirror) and of the decay of luminosity at various distances along the tube, the durations of these lines were determined. In some conditions they appeared to be roughly one thousand times greater than the values calculated theoretically as well as those given by previous experiments. As Lord Rayleigh states, the difference of behaviour of the lines is not very marked, and not always noticeable.

Since, presumably, one of the purposes of Lord Rayleigh's paper was to rouse discussion, I should like to put forward a possible explanation of his unexpected

results. The mean duration of lines is not always identical with the mean life in initial states of corresponding transitions. This would be the case only if no transitions from higher levels to the initial level of the line (cascade transitions), no recombination of ions, no transfer of excitation energy from atoms or molecules in metastable states, no 'imprisonment' of radiation, etc., took place. From these possibilities the first two, namely, cascade transitions and recombinations of ions, seem to be not excluded in Lord Rayleigh's experiments. Thus the most probable cause of the prolonged duration of the H_α , H_β and H_γ lines seems to be the recombination of atomic hydrogen ions.

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Jan. 28.

¹ Rayleigh, *Proc. Roy. Soc.*, A, 183, 26 (1944); cf. also *Nature*, 155, 84 (1945).

Vibration in Telegraph Wires

Two winters ago while motoring over a route traversed daily for many years, we observed this phenomenon for the first time. Hence the conditions giving rise to it must be rather exceptional. The vibration was so striking and unusual that we stopped the car to exclude the possibility of adventitious optical effects from that source. The time was about 9.15 a.m.; the air clear and 'frosty'; the sun brilliant; and the wires heavily loaded with ice. There was a barely perceptible breeze blowing across the road.

On the left side of the road were the usual telegraph wires, and on the right a group of four thicker insulated wires carrying lighting current. Both sets, although obviously under very different degrees of tension, were vibrating with considerable amplitude. The effect was general over several miles of road. Ultimately the right-hand wires changed direction and ran off sharply at right-angles to the road (that is, parallel to the wind stream). No vibration could be observed in this stretch. Later we ourselves turned right (that is, down wind) and here the standard telegraph wires also ceased to show any vibration.

In attempting an explanation several factors were reviewed. (1) The physical effect of temperature on the vibrating system, as defined by the 'sonometer' formula, can be ignored, as a drop of 40° C. only affects the rate by about 0.1 per cent. (2) From the dissimilar behaviour of the wires orientated across and parallel with the wind stream, we may safely presume that this cross flow is an essential factor. (3) Genesis from some random specific 'air velocity vibration resonance' correlation may be excluded, as two entirely dissimilar sets of wires were simultaneously in vibration.

In view of the above, we reached the conclusion of Gilbert *et al.*¹ that the vibration is initiated and maintained by the differential pressure effects resulting from an air flow across a wire of non-circular section; that this abnormal source of energy explains the abnormally high amplitude; that the visual effect is aided and intensified by the greatly increased thickness of the wires, and by the loading of the wires reducing the vibration rate below the threshold at which the persistence of vision obscures observation².

What surprised us at the time was that, despite the obvious relationship to a cross wind, the prevailing breeze was almost imperceptible.

D. BARRON CRUICKSHANK.
B. FALKNER LEWIS.

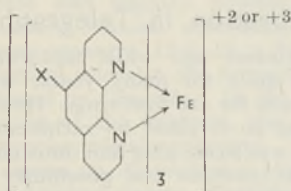
Papworth Hall,
Cambridgeshire.

Nature, 155, 243 (1945).

² cf. Bauchmetz and Whitehouse, *Nature*, 155, 243 (1945); "frequency approximately 10 a second".

Effect of Substituents on the Oxidation Potential of Ferrous *ortho*-Phenanthroline Complexes

IN a recent communication¹, Smith and Richter have measured the oxidation-reduction potentials of a series of substituted *ortho*-phenanthroline iron complexes.

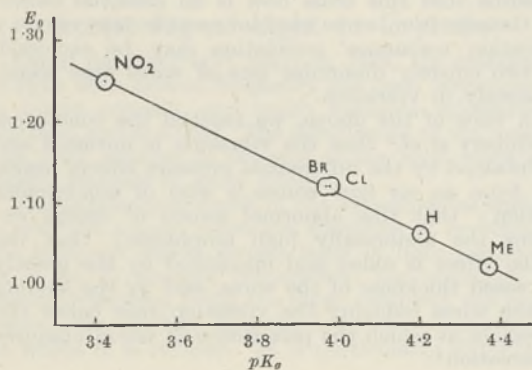


The values obtained show a marked trend with the dipole moments of the corresponding substituted benzenes. More striking, however, is the fact that a linear graph is obtained when these formal oxidation-reduction potentials are plotted against the (negative) logarithms of the dissociation constants² of the corresponding *para*-substituted benzoic acids.

E_0 and $\log K_a$ are, of course, proportional to the free energy changes of the corresponding reactions. Clearly, an electron shift, for example one towards the substituent group, which in the acid series raises

X	E_0 (volts)	pK_a
NO ₂	1.25	3.42 ₆
Br	1.12	3.97 ₁
Cl	1.12	3.97 ₇
H	1.06	4.20 ₃
CH ₃	1.02	4.37 ₃

The equation to the line is $E_0 = 2.08 - 0.243(pK_a)$.



the acid strength by increasing the repulsion on the proton, is similarly transmitted in the complex ion. The withdrawal of electrons is communicated through the co-ordinated nitrogen atoms to the central iron atom, to produce an increased binding of its electrons and a proportionate rise in the oxidation potential.

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¹ Smith and Richter, *Ind. Eng. Chem. (Anal. Ed.)*, 16, 580 (1944).

² Dippy *et al.*, *J. Chem. Soc.*, 1888 (1934); 343 (1935); 644 (1936).

Causality or Indeterminism?

I HOPE it will not cause *Nature* to lose caste for a very ordinary man to join in the discussion on causality v. indeterminism so ably dealt with by Prof. H. T. H. Piaggio, and to express thoughts that will at least be understood by all who try to read the exceedingly specialized correspondence columns.

I follow the line of argument that coin tossing is not really haphazard but governed by strict laws of causality, although the variation in launching and wind may be impossible scientifically to calculate. Incidentally, the alternative of red and black on a roulette board is the incalculable ideal, in that the ball launched round the board in the opposite direction to the spinning centre has to strike odd-shaped obstacles before rolling into the middle. Results have, I understand, for some obscure reason been chronicled for years.

When we come to atomic physics we get into heavy weather and we are not really helped by von Neumann's six laws, especially the one referring to the 'squared operator' which may convey that there is something wrong with the 'tote', but is otherwise entirely incomprehensible to the layman. Anyhow, at present the pundits plump for indeterminism.

How can this refreshing individuality in atomic physics, so stimulating in our dragooned world, react on 'homo sapiens' (sic)?

In Schrödinger's attractive book "What is Life?" with Darlington prompting him 'off', as they say on the stage, he tells us that we mortals are made a certain size in order that statistical results should obtain. A serious corollary, however, emerges in that genes are so small as to be subject to random changes as, for example, in the energy-level of their few constituent atoms. These changes are enough to account for mutants. Through no fault of our own, therefore, we may become the parents of monsters. May we now go further and be told by those who analyse the micromechanism that animates the brain whether there are there, constituent parts of such small size as also to be influenced by random atomic changes. If such be so, then the truly awful thought faces us, that all our wise decisions, all our noble or possibly questionable actions in life, are determined, not by our own high-charactered and noble 'ego', but by a microscopic atomic material part of our brain, over which we have no control, being bumped around on the quantum level.

These are grave thoughts, but if the latter hypothesis be true, although not exactly comforting, it would at least explain and indeed excuse many mistakes made in life by your obedient servant,

BRABAZON OF TARA.

RESEARCH ITEMS

Origin of South American and African Freshwater Fishes

WILLIAM A. GOSLINE (*An. Acad. Brasil. Ciencias*, 16, No. 3; 1944) criticizes some of the arguments advanced by biologists who have marshalled geological evidence to agree with their own interpretation of the biological data. While the author does not attempt to offer final conclusions concerning the African and South American freshwater fishes, he summarizes the evidence supplied by the best-known freshwater group, and suggests lines of further investigation. These are included under four heads. (1) The compilation of up-to-date revisions of the groups of fish involved, together with the presentation of phylogenies of these groups based on palæontological, anatomical and physiological data. These would show the relationship of the fishes between areas as compared with those within areas. (2) The demonstration from various sources of evidence that certain groups have originated and evolved in fresh water, and that salt water has always formed a complete barrier to their dispersal. (3) The determination, so far as is possible, of the geographical distribution—past and present—of these groups, together with their ecological limitations. (4) The correlation of all material from the above lines of investigation, special account being taken of the environmental needs affecting fish dispersal, with the derived data for other animal and plant groups and with geological and climatic history.

Growth Hormones in Tetraploids

F. G. GUSTAFSON (*J. Hered.*, 35, 269; 1944) has shown that tetraploid marigolds have 58 per cent and 76 per cent as much growth hormone as their related diploid, while the autotetraploid *Lycopersicon pimpinellifolium* has 56.8 per cent of that of the diploid. This reduction in amount of growth hormone may be related to the well-known time differences in growth between diploid and tetraploid plants.

Mitosis and Cell Differentiation in the Blood

L. F. LA COUR (*Proc. Roy. Soc. Edin.*, 62, 73; 1944) has used new technical methods to investigate the chromosome behaviour and nuclear cycle in the origin of blood cells in man, mice, rats, cats and dogs. There is a unique difference between the precursors of myelocytes and erythrocytes in respect of the nucleic acid content of the nucleus. The pre-erythrocyte cells stain an intense red by the Pappenheim stain, whereas the pre-myelocytes stain pink. Similarly the chromosomes of the first type show a greater desoxyribose nucleic acid charge. In man with pernicious anæmia, the differences are accentuated. This leads on one hand to over-spiralization and abnormal division in the overcharged erythrocytes, and long thin chromosomes, incompletely spiraled in the myelocytes. As a result of the abnormal divisions with multiple spindles and chromosome bridges, the daughter cells often contain irregular chromosome numbers. Hypoploid cells have been found in the normal field mouse. Nucleoli are present in all precursor cells in the marrow and are later replaced by heterochromatin. Their presence is correlated with cell proliferation. The matured myelocytes in the mouse and the rat are tetraploid as a result of an abortive anaphase of the last division. White tetraploid cells occur in association with a

shortage and red tetraploid cells with an excess of both nucleic acids in pernicious anæmia. Evidence is given which suggests that the enucleate condition of mature erythrocytes is due to the extrusion of nucleic acid and not of the nucleus.

Pre-harvest Drop of Apple Fruit

PRE-HARVEST drop of apple fruits which have reached or almost reached picking maturity is a serious problem confronting apple growers in America and, to a lesser extent, in Great Britain. Innumerable trials carried out in recent years have indicated that some control of this trouble may be effected by spraying the trees, shortly before picking maturity is reached, with growth-substance solutions. The standard spray used contains ten parts of growth substance per million of spray; but L. Southwick reports (*Proc. Amer. Soc. Hort. Sci.*, 42, 199; 1943) that stronger sprays may be more effective and that, while dusts which can be applied more easily are as effective as solutions with some varieties, they are less effective with others. Southwick, like M. B. Hoffman, A. V. Doren and L. J. Edgerton, finds dusts as effective as sprays with McIntosh apples. The addition of spreaders to the sprays is not necessary, but the sprays are ineffective if their application is followed by a spraying with water (or presumably rain) within two hours (E. L. Overholser, F. L. Overley and D. L. Allmendinger, pp. 211-219). Sprays given near midday are most effective, and the period of effectiveness may be as much as twenty-eight days, but is less if temperatures are high. The hormone sprays are without any direct effect on the firmness of the fruit or development of decay, breakdown and scald in store (M. H. Haller, pp. 207-210), but by delaying picking they may improve colour and taste and increase the size of the fruit as harvested by permitting the attainment of greater maturity (E. P. Christopher and S. A. Pieninzek, *ibid.*, 43, 29; 1943).

Mercury for Grain-Pest Control

THE method of grain-pest control as practised by the rayats in certain parts of India involves the use of mercury. It concerns the protection of stored pulses against the bean beetle, and for this purpose a drop of mercury is placed in an excavated soap nut and lodged in the storage container. D. W. Wright, of the School of Agriculture, Cambridge, has made an attempt to assess the efficacy of mercury for the control of several of the commoner grain pests (*Bull. Entom. Research*, 35, 143; 1944). Experiments showed that the vapour of mercury was fully effective in preventing reproduction of the grain weevil (*Calandra granaria*), the saw-toothed grain beetle (*Oryzophilus surinamensis*), the lesser grain borer (*Rhizopertha dominica*), and the Angoumois grain moth (*Sitotroga cerealella*). Zinc and tin amalgams and calomel were less effective than metallic mercury. The efficacy of a given weight of mercury is increased by subdivision, a process which increases its total surface area. The substances used were found to emit a vapour which contained free mercury. Storage of insects in mercury vapour was found to have no effect on the viability of grain weevils, neither did it influence their subsequent reproductive capacity. The action of the mercury was on the eggs, which failed to hatch. Germination and spectroscopic tests on grain that had been stored for several months with mercury gave no indication

that any contamination had occurred. The grain weevil was able to breed vigorously in grain so treated.

Crocidolite Asbestos in Western Australia

BLUE amphibole (riebeckite) asbestos occurs in seams interbedded with banded ironstones of Nullagine age in the Hamersley Ranges of Western Australia. The petrology of the deposits and the associated rocks has been described by K. R. Miles (Geol. Sur. W. Aust. Bull. 100; 1942), and there is also a report on the economic importance of the occurrences by J. S. Foxall. The banded ironstones include sideritic cherts, magnetite- and hematite-bearing cherts and banded jaspers associated, as usual, with quartzites. The ironstones are interpreted as chemical sediments in which the bulk of the iron was originally precipitated as ferrous carbonate. Under conditions of low-grade metamorphism, riebeckite has developed in these beds as (a) scattered needles; (b) massed aggregates of needles (potential crocidolite); and (c) seams of uniformly parallel cross fibres (crocidolite proper). In their geological setting, structure, composition and optical properties the riebeckite and asbestos occurrences are closely similar to those of the better-known South African deposits. The chief problem in both areas is the source of the soda required for crocidolitization. Riebeckite contains six per cent or more, whereas only traces of soda appear to be present in the adjacent formations. The current hypothesis that crocidolite occupies the place of pre-existing soda-rich layers in siliceous ironstones is therefore far from satisfactory. Another possibility is that soda may have been introduced (as in albite-schists) by emanations from plutonic sources, but the absence of igneous rocks and of regional metamorphism would seem to be inconsistent with this alternative. Both in Australia and South Africa the origin of crocidolite remains a geochemical enigma.

Viscosity of Compressed Gases

THE viscosity η of a non-ideal gas was considered in 1922 by Enskog, whose formula was checked for carbon dioxide and (by Michels and Gibson) nitrogen: $\eta = \eta_0 (1 + 0.175b\rho + 0.866^2\rho^2)$, where η_0 is the ideal gas viscosity, ρ is density, and b is van der Waals' constant. O. Leipunsky (*Acta Physicochim. U.R.S.S.*, 18, 172; 1943) has shown that the formula gives quite satisfactory results for a number of gases, with a tendency at high densities to show rather higher values than the experimental, due to the change of b with pressure. The formula is thus of service in technical calculations where compressed gases are concerned. With a suitable value of b the formula also applies to mixtures, where the mathematical theory is extraordinarily clumsy and incomplete.

Absorption Spectra of Substituted Benzene Sulphonamides

ALTHOUGH several publications have dealt with the ultra-violet absorption spectra of sulphanilamide derivatives, little has been done towards identification and characterization of the individual absorption bands. J. M. Vandenbelt and L. Doub (*J. Amer. Chem. Soc.*, 66, 1633; 1944) have made a study of simple sulphanilamide derivatives and find that they have one single band of strong absorption (ϵ , about 17×10^3) in the accessible ultra-violet region, about 260 $m\mu$ in neutral solution, which shifts to shorter

wave-length when the solution is made alkaline, and decreases in intensity with acidity. Simple substitution which does not change the basic ionization properties of the molecule has little effect on the wave-length of the band. With more complicated substitution, other bands appear. Sulphathiazole has a band at 257–259 $m\mu$ with the properties of the sulphanilamide band; and a band at 280–283 $m\mu$ which shifts to shorter wave-length in alkali and is not destroyed in 2*N* hydrochloric acid, and is probably due to the thiazole portion of the molecule. With sulphapyridine three bands are found, at 242, 261 and 311 $m\mu$, the third being due to the pyridine portion. In alkaline solution the maximum at 311 $m\mu$ shifts to shorter wave-length and the peaks at 242 and 261 $m\mu$ apparently fuse to a single broad band of increased intensity at 245 $m\mu$. With sulphadiazine a 257 $m\mu$ band is due to the *p*-aminobenzene sulphonamide absorption and a 241 $m\mu$ band to the pyrimidine ring. Such comparisons with simpler analogous compounds make it possible to associate the bands with absorbing groups in the molecules.

Pulsation Theory of Cepheid Variables

P. L. Bhatnagar and D. S. Kothari, Department of Physics, University of Delhi, in a paper "A Note on the Pulsation Theory of Cepheid Variables" (*Mon. Not. Roy. Astro. Soc.*, 104, 292; 1945), deal with certain points raised in Prof. Svein Rosseland's George Darwin Lecture (see *Nature*, 153, 261; 1943). Rosseland developed his theory of 'anharmonic pulsations' and found that the semi-amplitude of oscillation would have to be a quarter of the star's radius—a value which is four or five times too great for most of the Cepheids. The authors of the present paper point out that this and other results obtained by Rosseland are not inherent in the model, but arise because of an approximation introduced in the investigation. They treat the matter in a simpler way than Rosseland, assuming γ , the ratio of the specific heats, to be 5/3, and avoiding the approximation introduced by Rosseland. The conclusion is that the theory of anharmonic oscillations for the above ratio cannot account for the observed skewness in the velocity-time curve of the Cepheid variables. The observed skewness demands a semi-amplitude almost equal to R , whereas the observed value is about 0.1 R , unless the value of γ is assumed to be much greater than 5/3. A rough calculation shows that if the observed skewness is to arise for a semi-amplitude of 0.1 R , γ is comparable to 10.

Van Biesbroeck's Star

IT is announced (*Harv. Obs. Card* 697) that W. J. Luyten and P. D. Jose have found the colour index of Van Biesbroeck's faint companion to BD+4°4048 to be 1.4 and the photographic magnitude 19.5, giving a photovisual magnitude of 18.1. The colour index was derived from blue and yellow plates taken with the 36-in. reflector of the Stewart Observatory. It is surprisingly low for so faint a star (absolute magnitude 19.3 photovisually) and in addition there are several stars in the vicinity which are as red as, or even redder than, the proper motion star. This suggests the possibility that this star, which has the lowest known luminosity, is a degenerate star and approaches a black dwarf. It is remarked that it might be a star the surface temperature of which corresponds to that of an early *M* dwarf, but the luminosity of which is several thousand times lower.

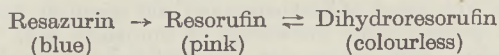
OXIDATION-REDUCTION ASPECTS OF RESAZURIN

By the late R. S. TWIGG

London School of Hygiene and Tropical Medicine
and

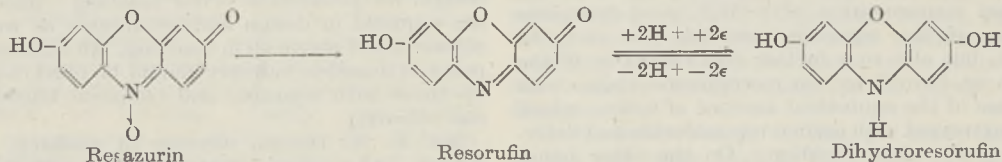
National Institute for Research in Dairying

RESAZURIN was discovered by Weselsky¹, and first used by Pesch and Simmert in 1929² for estimating the bacterial content of milk. It has lately been extensively used in Great Britain as a basis for a number of tests for the hygienic quality of milk^{3,4}. Reduction takes place in two stages



In fresh milk, reduction is chiefly due to cells (mastitis, etc.), and in aged (for example, 24 hours old) milk, to bacteria.

Work has been carried out electrometrically at 30° C. in the absence of oxygen, on the two stages of reduction :



Only the second stage of the second reduction is reversible at an inert electrode.

Electrometric titration curves of resazurin at pH₁ 6.55 compared with curves of the same amount of resorufin at the same pH show that during the first reduction some of the latter is simultaneously reduced to dihydroresorufin (Fig. 1). This is true, at least, between pH values of 6 and 7.

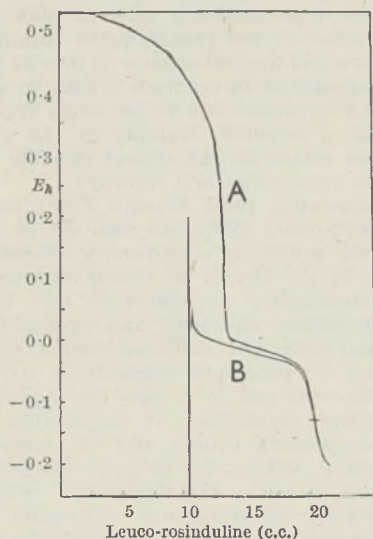


Fig. 1. A, TITRATION OF 20 O.O. RESAZURIN.
B, " " " " RESORUFIN.
All solutions 0.000132 M, pH 6.55.

The courses of the oxidation-reduction curves of the reaction resorufin \rightleftharpoons dihydroresorufin resemble those of nearly all other reversible dyestuffs in that two electrons per molecule are transferred in the reaction, at any rate at pH values greater than 3.0.

The E'_0 -pH curve, constructed from the table on p. 402, is shown in Fig. 2. All points were taken from measurements made by the 'method of mixtures', but some, including those at pH 6.583, 6.867 and 7.431, have been confirmed by titration.

The curve shows four sections having $-dE_h/dpH$ values of 0.03, 0.06, 0.09 and 0.06 successively from high to low values of pH. This, together with the other chemical aspects, shows that the system conforms to W. M. Clark's formulation $Ox + 2e = \bar{Red}^2$.

The electrode equation which describes the above findings and agrees with the observed values in the table is :

$$E_h = E_0 - 0.03006 \log \frac{[S_R]}{[S_O]} + 0.03006 \log \left[\frac{K_1 K_2 (H^+) + K_1 (H^+)^2 + (H^+)}{K_0 + (H^+)} \right]$$

The calculated value of pK_0 is 6.93, and of E_0 is $+0.380$ v. By adopting for pK_1 and pK_2 the values

9.26 and 10.02 respectively, the calculated values are given in the table.

The calculated and observed values agree fairly well, except at pH values of 6.583, 6.867 and 7.431 (of which the first two fall within the normal range of the pH of milk). These three large deviations may be due to low solubility characteristics, but it was deemed unwise to decrease further the concentration of the dye (which is 0.000015 M in the experiments), owing to the ease of re-oxidation of dihydroresorufin by traces of oxygen.

From pH 3 up to the high acidities of hydrochloric

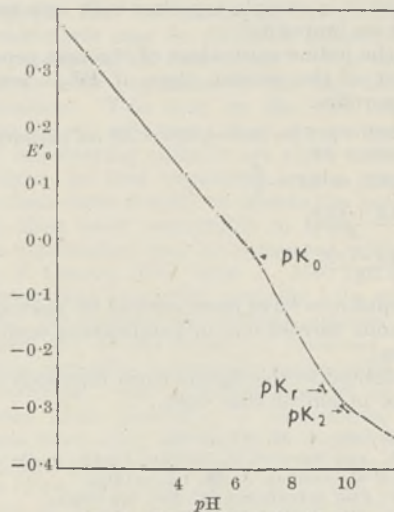


Fig. 2. RELATION OF E'_0 TO pH.

INDUSTRY AND UNIVERSITY EDUCATION

THE proceedings of the Conference of Industrial Representatives on "Industry and University Education", convened by the Vacation Work Committee of the Imperial College of Science and Technology Union on December 15, have now been published. At the first session, on "Post-war Technical Requirements in Industry", Dr. P. Dunsheath, in a paper on "Industry's Requirements in Personality", suggested that university education tends to lay too much emphasis on the working of things and to give insufficient attention to human relationships and the working of the mind. University graduates are of much greater value to industry when, in addition to their equipment of mathematical and scientific data, they possess some knowledge of humanity with its intricate and sometimes contradictory relations. Urging that the universities should concern themselves with developing the characteristics making for leadership, Dr. Dunsheath emphasized the importance of a sense of proportion and the ability to get ideas understood by others. He believes that more attention should be given to the classification of students according to their real aptitude for research, for design, for production or for teaching: good brains are required in design and production as well as in research, and above all in teaching. All administrative posts in scientific industry should be filled, he thinks, by those with scientific and technical knowledge of the industry.

Mr. E. R. Davies, director of research, Messrs. Kodak, Ltd., pointing out that the problems of the industrial research worker always tend to lead him back to problems in pure or applied science which are not peculiar to his industry but of much wider interest, deprecated further specialization during the undergraduate years. More emphasis should be placed on postgraduate work, but the men required should be scientists first and technologists second. He thinks that technologists in the production and distribution sides would be drawn largely from the technical colleges. Although he would welcome the establishment of a university chair in photography, he would prefer to see postgraduate training continued in pure and applied science as it is at present. Its main aim should be to train a man in research methods, but he would like to see some broadening of the basis of scientific training at the graduate stage. There should be the closest possible contact between the universities and industry.

In the discussion, Lord Eustace Percy suggested that industry should find more men within its own ranks who are worthy of a university education and could profit by it. Dr. G. M. Dyson referred to the need for thoroughly re-organizing the technical colleges, adequately endowing and equipping them and providing them with sufficient men to cope with teaching and to prosecute research as well. Dr. J. A. C. Williams put in a plea for including the philosophy and psychology of engineering in the university engineering course, and for increased use of the technical colleges for refresher purposes.

The second session of the Conference, which considered "Post-war Requirements in Scientific Education", was opened by Prof. L. Bairstow, who pointed out that scientific education cannot be considered adequately as a separate subject apart from the rest of life, and referred to the economic difficulties

pH	Calculated	Observed	Deviation
0.188	+0.369 v.	+0.369 v.	0.000
1.005	0.320	0.322	-0.002
1.390	0.297	0.299	-0.002
2.454	0.232	0.231	+0.001
3.392	0.176	0.176	0.000
4.477	0.111	0.111	0.000
5.570	0.045	0.045	0.000
6.119	+0.010	+0.012	+0.002
6.583	-0.021	-0.016	+0.005
6.867	0.042	0.032	-0.010
7.431	0.085	0.081	-0.004
7.880	0.123	0.122	-0.001
8.338	0.163	0.163	0.000
9.186	0.231	0.231	0.000
9.547	0.256	0.256	0.000
10.053	0.284	0.285	+0.001
10.605	0.307	0.308	+0.001
11.454	0.335	0.336	+0.001
11.743	0.344	0.345	+0.001
12.228	-0.359	-0.360	+0.001

acid or sulphuric acid, a blue-green compound, presumably a meriquinone, is formed by the reduction of resorufin with titanous salts, or by oxidation of dihydroresorufin with quinone or potassium dichromate. While the reduction method shows that a meriquinone having an oxidant: reductant ratio of 1:1 occurs, the oxidation method, curiously, shows a 3:2 ratio.

If a solution of resazurin be acidified to 4.76 *N* with hydrochloric acid, and potassium iodide be added to a final concentration of 0.06 *N*, a spontaneous reduction of the resazurin proceeds not only to resorufin, but also to a further half reduction of the resorufin so formed to the meriquinone stage, with the release of the equivalent amount of iodine, which may be extracted with carbon tetrachloride and determined by an iodate titration. On the other hand, if the resazurin be acidified to 3 *N* with sulphuric acid or about 1.2 *N* with hydrochloric acid, and potassium iodide added to 0.06 *N*, only the complete reduction of resazurin, without further reduction of the resorufin so formed, occurs. This difference depends upon the low solubility of resorufin in the medium, and upon the observation that at these high acidities the potential of an iodine-potassium iodide mixture at an inert electrode decreases with increasing acidity, which is contrary to experience with other systems.

Commercial resazurin contains variable amounts of resorufin. These latter findings have led to the development of a method for estimating the amount of resazurin in a sample together with any resorufin present as an 'impurity'.

If *A* is the iodine equivalent of the first procedure, and *B* that of the second, then, if *RZ* = resazurin, *RF* = resorufin:

$$A = 2RZ + [RZ \text{ (as 'formed' } RF) + RF \text{ (as 'impurity')}]$$

$$= 3RZ + RF$$

$$B = 2RZ, \text{ or } RZ = \frac{B}{2}$$

$$\therefore A = \frac{3B + 2RF}{2}$$

$$\text{and } RF = \frac{2A - 3B}{2}$$

These equations have been verified by electrometric investigations carried out in conjunction with iodine estimations.

I am indebted to the Agricultural Research Council for a grant in aid of this work.

¹ Weselsky, *Berichte*, 4, 32, 613 (1871).

² Pesch, K. L., and Simmert, U., *Milchw. Forsch.*, 8, 551 (1929).

³ Baker, W., et al., *Biochem. J.*, 36, 1/2, i (1942).

⁴ Davis, J. G., *Food Manufacture*, 17, 308, 344 (1942).

⁵ Clark, W. M., *U.S. Pub. Health Rep.* (Reprint No. 826).

attending any extension of a student's career, especially for the majority whose work is less absorbing than research and where compensations are necessary. Specialization, or differentiation, should not come before the third year, and even then should not involve a student being committed to one field for the rest of his life. He believes that we need more training in administration for a limited number of people, who would in due course take their place with those who have studied life from a different aspect. Then we should retain, and possibly extend, a completely free atmosphere for those students who take naturally to research. We also need a better administrative attitude to research, and also technical high-schools and extended facilities in the ordinary technical schools.

Prof. H. V. A. Briscoe confined himself to the question of producing men destined for teaching positions in pure and applied science and in the industries using applied science. He stressed the importance in recruitment of selection and of widening the field of choice; we must look critically and constructively at this question of extended recruitment and make a scientific career attract more of the really good men who at present go into other fields. Then he stressed the importance of excellence in the teaching staff with reference to imparting selected principles and facts in science so as to inculcate and develop intellectual integrity and to display the cultural aspects of science, as well as to the provision of opportunities for special development. Curricula are overloaded, and we must remember that the task is education, not teaching. Lastly, there is the question of assessment and guidance in the valuation of the graduate, so that he does what is best in his own interest and in the interests of the community. Here full co-operation of the employer is essential. With regard to the desirability of having first-class men for production, he believes that the choice between research and production should be left open and that we should aim at turning out keen, properly equipped scientific workers, whose careers would be determined by their aptitudes and opportunities.

Dr. R. V. Southwell, stressing the importance of a real partnership with industry, suggested that we may find that the best arrangement is not one in which three years at a university are followed by two years in industry, but one in which the last of the five years sees a man returning to his university. A man who enters industry should not have finished with his university, and we might well keep a more open mind on the order in which the years are spent between industry and the university.

Mr. J. W. Sawtell emphasized the importance of good management; he thinks that we should impress on the universities the need for men with a scientific education who can manage and handle other people, and appreciate the importance and dignity of management as a profession. Mr. L. P. Combes pointed out that regard must be had to the question of national service and its incidence on the age of recruitment. Mr. D. A. Bell thinks that one reason why graduates tend to enter industry only in research departments is that management has not been regarded as a worthy or scientific profession. In written subsequent contributions, Mr. W. S. Flight referred to the economic difficulties of a long period of training and a possible solution through the State bursary scheme, and Mr. M. I. Freeman urged that some training in the principles of industrial administration and

organization should be given by the university rather than by industry.

Dr. A. J. F. Welch referred to the importance of vacation work and of having on academic staffs those with first-hand acquaintance with industrial conditions, while Dr. F. M. Potter, urging the value of a sound fundamental knowledge and elementary background of several subsidiary sciences, suggested that students would do well to avoid the tendency to live with men in the same year who are studying the same branch of science.

MODE OF ACTION OF PENICILLIN

IN an article on penicillin treatment in *Nature* (677, Nov. 25, 1944) reference was made to the work of Lieut.-Colonel J. W. Bigger (*Lancet*, 497, Oct. 14, 1944), who concluded that penicillin actually kills *Staphylococcus pyogenes*. He suggested that it kills them at the time of division and has no effect upon individual cocci which are not dividing. These, therefore, persist in broth cultures, which penicillin frequently fails to sterilize, and are the explanation of that failure. Bigger proposed to give penicillin intermittently, in the hope that these 'persisters' would begin dividing in the intervals of the penicillin doses and so would be killed by the next dose. Bigger refers to the work of C. D. Gardner (*Nature*, 146, 837; 1940), who found that, in weak concentrations of penicillin, cocci swelled to three times their normal size without division, and bacilli showed similar changes.

E. W. Todd (*Lancet*, 74, Jan. 20, 1945) also refers to this and other work in his report on his experiments on the bacteriolytic action of penicillin. Working with *Pneumococcus* Types I, II and III and with *Streptococcus viridans*, haemolytic streptococci, staphylococci and *Clostridium welchii*, he found that all the strains of these organisms which he used were lysed by penicillin, but that such organisms as *Bact. coli* and *Pseudomonas pyocyanea*, which resist penicillin, were not lysed by it. But penicillin, he concluded, can kill organisms without lysis. When lysis occurs, its rate depends on the actual or potential rate of multiplication of the organisms. Their multiplication, as G. L. Hobby, K. Meyer and E. Chaffee (*Proc. Soc. Expt. Biol.*, N.Y., 50, 281; 1942) also found, is essential for the action of penicillin. "It would appear that bacteriostasis, bactericidal action and bacteriolysis may be different stages of a single process proceeding in that order." The most rapid lysis occurs with organisms at the maximal rate of multiplication. This may be the real reason why penicillin is so effective, that is, because young actively multiplying cultures are more susceptible to bacteriolysis, so that organisms in the phase which enables them most readily to invade the human body are also then most susceptible to lysis.

These conclusions may be compared with those of Prof. L. P. Garrod (*Brit. Med. J.*, 108, Jan 27, 1945), who agrees that penicillin actually kills susceptible bacteria. He quotes the further opinion of L. A. Rautz and W. M. M. Kirby (*J. Immunol.*, 48, 335; 1944) that penicillin is actually bactericidal. Garrod gives, however, only qualified support to Bigger's hypothesis that penicillin is bactericidal only to organisms when they are about to divide, which was, he says, also put forward by G. L. Hobby and M. H. Dawson (*Proc. Soc. Expt. Biol.*, N.Y., 56, 178; 1944) and by C. P. Miller and A. Z. Foster (*ibid.*, 56, 205).

Against this hypothesis, Garrod maintains, are (1) his experiments on the effects of temperature; like other disinfectants, penicillin is more active at higher temperatures, but is even more active at 42° C., when bacterial growth ceases, than at 37° C.; incidentally, Garrod finds that its action is impaired by increase of the acidity between pH 7.0 and 5.0; (2) the fact that bacteria from both old and very young cultures are almost uniformly susceptible. Garrod therefore thinks that there is no conclusive evidence in support of Bigger's proposal to give penicillin intermittently, and claims that clinical experience supports his view. Penicillin treatment fails because the organisms are inaccessible inside necrotic areas or in undetected abscesses.

Further important conclusions drawn by Garrod are that nothing is to be gained by using higher concentrations of penicillin (cf. Sir A. Fleming, *Lancet*, 621, Nov. 11, 1944; see also *Nature*, 155, 341, March 17, 1945), especially in local treatment. The idea that higher doses will be more effective does not apply to penicillin. The reverse is truer. A concentration of 1 unit per c.c. is not only just as effective as one of 1,000 units, but is often more effective. The only good reason for using stronger solutions in local treatment is to ensure that the concentration does not fall below the minimum fully effective level of about 0.1 unit per c.c. Garrod further emphasizes the importance of the purity of the penicillin which is being used experimentally. He found that all commercial penicillins tested were less active in higher than in low concentrations. Presumably impurities were responsible for this, and they cause serious obstacles to the study of the action of penicillin. It will be necessary to find out whether penicillin is a single substance of unvarying composition and uniform action.

Discussing these results in a valuable leading article, the *British Medical Journal* (123, Jan. 27, 1945) directs attention to the enormous variation in the susceptibility of various bacteria to penicillin. Some species classed as totally resistant are affected by higher concentrations of penicillin; for example, the typhoid bacillus and the salmonellas. H. F. Helmholz and C. Sung (*Amer. J. Dis. Children*, 68, 236; 1944) have found that some resistant bacteria in the urine are affected by high concentrations, for example, *Proteus* and some strains of *B. coli*. Only *Bact. aerogenes* and *Pseudomonas pyocyanea* remained unaffected. The treatment of some infections of the urinary tract with penicillin might thus be effective. E. W. Todd, G. S. Turner and L. G. W. Drew (*Brit. Med. J.*, 111, Jan. 27, 1945) have found that *Staphylococcus* strain Oxford H. can be trained by growth in increasing quantities of penicillin to become 3,000 times more resistant to penicillin than it originally was. Similar results were obtained with another strain of *Staphylococcus*. Unlike other organisms which become 'drug-fast', however, *Staphylococcus* lost this property rapidly in media not containing penicillin. The authors refer to work which showed, on the other hand, that pneumococcus type III, made resistant to penicillin, either by culture in media containing penicillin (G. Rake *et al.*, *J. Immunol.*, 48, 271; 1944) or by passage through mice treated with penicillin (L. H. Schmidt and C. L. Sesler, *Proc. Soc. Expt. Biol.*, N.Y., 52, 353; 1943), retained its resistance. The nature of these phenomena of resistance requires further investigation. Although some organisms can produce a penicillinase which destroys penicillin (see, for example, the penicillinase produced

by *B. subtilis* reported by E. S. Duthie, *Brit. J. Expt. Path.*, 25, 96; 1944), resistance to penicillin apparently does not always depend on the production by the resistant organism of penicillinase. W. M. Kirby (*Science*, 452, June 2, 1944) has extracted a substance which is not penicillinase from *Staphylococcus* resistant to penicillin. G. LAPAGE.

INDIAN FOREST YIELD TABLES

EVER since the Forest Research Institute came into being at Dehra Dun (1907), the Sylvicultural Branch set out to obtain data for the preparation of volume and yield tables for some of the more important timbers such as teak, sal, and deodar, to mention but three of the best known throughout India. Selected sample plots of varying type and age had been previously formed by the forest officer in different parts of India, and more or less periodically measured and records kept. But for the most part the work was spasmodic and a proportion at least of the data obtained of doubtful usefulness.

As a result of the work inaugurated, attempts were made to prepare yield tables, among others, for the sal (*Shorea robusta*); such a table was prepared by Smythies and Howard and published in 1923. It was based on the measurements of some fifty-two plots of sal, chiefly in the United Provinces, with a few in Bengal and the Central Provinces. The sal has a wide distribution from the foothills and neighbouring border in the plains in the United Provinces as far west as the Jumna River, eastwards along this line through Nepal and Bengal Duars into Assam as far as Tezpur, its eastern boundary. To the south it is found in the eastern part of the Central Provinces and in Chota Nagpur, south-western Bengal, Orissa Province and Orissa Feudatory States to Ganjam in the Madras Provinces. It thus is equally at home in a dry hot as well as in a damp hot climate, and grows on a variety of soil conditions. Since the above tables were published, many more data have been collected, and this information has been collated in *Indian Forest Records* (Sylviculture) New Series, "Yield and Stand Tables for Sal (*Shorea robusta*) High Forest" (4.A., No. 4, Model Press, Delhi, 1943) by M. L. Griffith, sylviculturist, and Bakhshi Sant Ram. The present tables are based on 542 measurements from 225 sample plots in twenty-five forest divisions of five provinces. Sample plot selection, upkeep and measurements in the different provinces are now greatly facilitated by the existence in the provinces of provincial sylvicultural research officers whose investigations and results are available to the Central Research Institute. That this departure is of the highest value is evidenced by the authors' remark, "The tables now produced are admittedly not completely satisfactory on account of the abnormality of some of the basic data. The main difficulties arose through inconsistent thinning procedure. These have been described in more detail together with the methods attempted to overcome them."

Just as the progress in ordered management of a forest department is indicated by the number of the forests which have been placed under working plans, including the type of plan in force, so the degree to which sylvicultural work has advanced is evidenced by the possibility of being able to prepare suitable yield and stand tables for use in the forests under management.

ADSORPTION OF WATER BY PROTEINS

It is recognized that proteins contain two types of hydrophilic groups capable of binding water by hydrogen-bond formation, namely, polar side-chains such as those from lysine, glutamic acid, tyrosine, etc., and the oxygen and nitrogen associated with peptide bonds in the peptide chains. Adsorption curves are of the typical *S*-shape separable into three segments, the first part, at low pressures, characteristic of Langmuir adsorption, a second part with a more or less linear relation between adsorbed amount and vapour pressure, and a third part corresponding with a large increase of amount adsorbed with increase of vapour pressure.

H. B. Bull (*J. Amer. Chem. Soc.*, 66, 1499; 1944), who defines protein hydration as water released when moist protein in equilibrium with saturated water vapour at 25° or 40° is dried in vacuum for 24 hours at 105°, and calculates the free energy and heat changes in adsorption, concludes that the theory of multi-layer adsorption proposed by Brunauer, Emmett and Teller (*J. Amer. Chem. Soc.*, 60, 309; 1938) explains the results in a very satisfactory manner. This extends the Langmuir theory of monolayer gaseous adsorption to the case where more than one layer of molecules are adsorbed, and the resulting curves were found to resemble those obtained in the experiments.

The results are believed to be consistent with the view that the protein molecules in the solid state are linked together to form coherent planes, the exposed surfaces of which are hydrophilic, and water is adsorbed between these planes. The final rise is thought to correspond with a saturation of exposed polar groups with water and the beginning of a process of solution of the protein. Heat coagulation of egg albumin seems to involve interaction between polar groups on neighbouring molecules, with a decrease in water-binding capacity.

It is thought that there is no direct relation between the amount of water held by a solid protein in a saturated atmosphere and the amount of water held by a protein when it is dissolved in water, the latter being mainly dependent on the total hydrophilic surface exposed to the water.

EFFECT OF MULCHING ON THE SOIL

MULCHING is a recognized method of conserving soil moisture, but often several other effects of the treatment are noticeable. This is not, of course, unexpected when the mulch consists of organic material containing soluble plant nutrients in greater or less amount.

I. W. Wander and J. H. Gourley¹ found that mulching with straw increased the contents of potassium, calcium, magnesium, phosphorus and boron in the soil, the effect being most marked for potassium, while H. Painter and G. F. Potter² report that with young tung trees mulching reduced signs of potassium deficiency; and C. E. Baker³ found a mulch as effective as dressings of muriate of potash in increasing the potassium content of apple and peach leaves. These results may not be due entirely to potassium supplied by the mulch, as C. E. Baker⁴

found that mulching with cinders or glass wool increased the potassium content of apple leaves, possibly because under the mulch a concentration of feeding roots near the soil surface, where potassium concentration is highest, occurred. Mulching with poor hay, also with apples, encouraged the production of surface feeding roots in addition to increasing soil moisture⁵.

The effects of mulching, however, are not always beneficial, and L. P. Latimer and A. P. Percival⁶ found that although hay or seaweed mulches, as compared with grass covering, increased growth and fruit sizes in apples, sawdust used as a mulch did not have this effect, but did increase fruit and decrease leaf colour, suggesting that it had induced a slight nitrogen deficiency. W. A. Johnson⁷, using sawdust as a surface mulch for tomatoes, found that it decreased the soil nitrate content slightly and when incorporated in the soil, as mulch materials usually are eventually, depressed the soil nitrate appreciably so that heavier nitrate applications were required. The sawdust conserved soil moisture and caused the soil to be less compact, but repeated sawdust mulches may have undesirable effects. L. M. Turk and N. L. Partridge⁸ found peat unsatisfactory as a mulch as it prevented light rain from reaching the soil, while loss by evaporation from the mulch continued. These ill-effects were not found when the mulch used allowed free percolation of water, and gravel, straw and sawdust were all effective in this respect.

¹ *Proc. Amer. Soc. Hort. Sci.*, 42, 1 (1943).

² *Proc. Amer. Soc. Hort. Sci.*, 42, 17 (1943).

³ *Proc. Amer. Soc. Hort. Sci.*, 39, 33 (1941).

⁴ *Proc. Amer. Soc. Hort. Sci.*, 43, 7 (1943).

⁵ *Proc. Amer. Soc. Hort. Sci.*, 42, 30 (1943).

⁶ *Proc. Amer. Soc. Hort. Sci.*, 44, 52 (1944).

⁷ *Proc. Amer. Soc. Hort. Sci.*, 44, 407 (1944).

⁸ *Proc. Amer. Soc. Hort. Sci.*, 38, 59 (1941).

FORTHCOMING EVENTS

Wednesday, April 4

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. F. J. Macdonald: "The Freezing Point of Sour Milk"; Dr. H. Liebmann and Mr. A. D. Ayres: "The Electrometric Determination of Ascorbic Acid"; Mr. H. W. Webb: "Magnetic Stirring in the Electro-Deposition of Metals".

INSTITUTION OF ELECTRICAL ENGINEERS (RADIO SECTION) (joint meeting with the TELEVISION SOCIETY) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. D. C. Birkinshaw and Mr. D. R. Campbell: "Studio Technique in Television".

Thursday, April 5

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. L. J. C. Connell, Mr. O. W. Humphreys and Mr. J. L. Rycroft: "The Place of Radiant, Dielectric and Eddy Current Heating in the Process Heating Field".

ROYAL AERONAUTICAL SOCIETY (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 6.30 p.m.—Dr. A. G. Pugsley: "Modern Experimental Work on Aeroplane Structures".

Friday, April 6

INSTITUTION OF ELECTRICAL ENGINEERS (MEASUREMENTS SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Are Engineers Losing their Sense of Proportion on the Accuracy of Industrial Measurements?" (to be opened by Mr. H. D. Hawkes).

INSTITUTE OF PHYSICS (SCOTTISH BRANCH) (in the Natural Philosophy Department, The University, Glasgow), at 7.30 p.m.—Dr. W. Hume-Rothery, F.R.S.: "The Theoretical Interpretation of Alloy Structures".

Thursday, April 5—Monday, April 9

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

Friday, April 6

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

Saturday, April 7

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

Sunday, April 8

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

Monday, April 9

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

APPOINTMENTS VACANT

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

DEPUTY BOROUGH ELECTRICAL ENGINEER AND MANAGER to the Borough of Barking—The Ministry of Labour and National Service, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. D.1048.XA) (April 9).

GRADUATE TEACHER OF MECHANICAL OR ELECTRICAL ENGINEERING in the Southend Municipal College—The Chief Education Officer Education Office, Warrior Square, Southend-on-Sea (April 10).

PATENT AGENT, preferably specializing in ELECTRONICS, as Assistant in Patent Department—The Ministry of Labour and National Service, Appointments Department, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. F.3427.XA) (April 11).

MECHANICAL ENGINEER (fully qualified), in N.W. Area, by Engineering Company designing and constructing Electricity Generating Stations and Industrial Plants—The Ministry of Labour and National Service, Appointments Department, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. C.2512.XA) (April 12).

GRADUATE ASSISTANT LECTURER in the MECHANICAL ENGINEERING DEPARTMENT in the Coventry Technical College—The Director of Education, Council House, Coventry (April 16).

ASSISTANT LECTURER AND DEMONSTRATOR in BOTANY—The Principal, Royal Holloway College, Englefield Green, Surrey (April 21).

LECTURER in PHYSICAL AND INORGANIC CHEMISTRY—The Secretary and Registrar, The University, Bristol (April 23).

ORGANIC CHEMIST in the RESEARCH DEPARTMENT of a well-known firm in the London area, to carry out experimental work leading to the formulation of protective and decorative coatings for sheet-metal containers—The Ministry of Labour and National Service, Appointments Department, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. F.2719.XA) (April 26).

MECHANICAL AND ELECTRICAL ENGINEERS by the Gold Coast Government Public Works Department—The Ministry of Labour and National Service, Appointments Department, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. C.2526.A) (April 28).

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

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

ASSISTANT SECRETARY to the INSTITUTE OF PHYSICS—The Secretary, Institute of Physics, c/o The University, Reading, Berks. (April 28).

LECTURER in ELECTRICAL ENGINEERING—The Registrar, The University, Sheffield (April 30).

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

KEEPER OF THE DEPARTMENT OF ZOOLOGY—The Director, Museum and Art Gallery, New Walk, Leicester (April 30).

METALLURGIST for a position in the RESEARCH DEPARTMENT of a large firm in South Wales—The Ministry of Labour and National Service, Appointments Department, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. F.2720.XA) (May 12).

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

UNIVERSITY CHAIR OF CHEMISTRY tenable at King's College—The Registrar, University of London, c/o Richmond College, Richmond, Surrey (May 18).

READERSHIP IN HUMAN PHYSIOLOGY—The Registrar, University Registry, Oxford (June 16).

KEEPER OF THE DEPARTMENT OF ART—The Director, National Museum of Wales, Cardiff (June 30).

GEOLOGIST to the Government of Trinidad to co-ordinate geological information, compile geological map after necessary surveys and advise on geological questions connected with petroleum industry development in the Colony—The Ministry of Labour and National Service, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. F.3769.A) (August 31).

MECHANICAL INSPECTOR OF WORKS (temporary) by the Government of Sierra Leone for the Electricity Branch of the Public Works Department—The Ministry of Labour and National Service, Appointments Department, A.3(A), Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. O.S.605).

EDITORIAL ASSISTANT by British Council to help in production of a monthly journal published in several languages—The Ministry of Labour and National Service, Appointments Department, A.3(A), Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. F.Q. 144).

DIRECTOR OF THE CITY OF LONDON COLLEGE—The Secretary, City of London College, Electra House, Moorgate, London, E.C.2.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Medical Research Council: Industrial Health Research Board. Report No. 87: The Relation between Illumination and Visual Efficiency—the Effect of Brightness Contrast. By H. C. Weston. Pp. 36. (London: H.M. Stationery Office, 1945.) 9d. net. [272]

University of Birmingham. Report of the Vice-Chancellor and Principal to the Council, for the Calendar Year 1944, with an Appendix containing an Analysis of Student Numbers in the Forty-fourth Session, 1943-1944. Pp. 22. (Birmingham: The University, 1945.) [18]

British Rubber Producers' Research Association. Publication No. 50: The Structure of Polyisoprenes, Part 3: Ultra-violet Absorption Spectra. By L. Bateman and H. P. Koch. Pp. 8. (London: British Rubber Producers' Research Association, 1944.) [13]

Cambridge Joint Advisory Committee for Mathematics. Syllabuses for Examinations taken by Sixth Form Pupils. Published for University of Cambridge Local Examinations Syndicate and Oxford and Cambridge Schools Examinations Board. Pp. 12. (London: Cambridge University Press, 1945.) 6d. [13]

Control Surface Design in Theory and in Practice. By M. B. Morgan and Thomas. Pp. 28. (London: Royal Aeronautical Society, 1945.) [13]

Ministry of Fuel and Power. Report on the Severn Barrage Scheme. By A. G. Vaughan-Lee, Sir William Halcrow and S. B. Donkin. Pp. 32. (London: H.M. Stationery Office, 1945.) 2s. 6d. net. [23]

University of Leeds: Department of Coal Gas and Fuel Industries, with Metallurgy. Report of the Livesey Professor, D. T. A. Townend, for the Session 1943-44. Pp. 20. (Leeds: The University, 1945.) [23]

Other Countries

U.S. Department of Agriculture. Miscellaneous Publication No. 531: A Review of Studies on the Mexican Fruitfly and related Mexican Species. By A. C. Baker, W. E. Stone, C. C. Plummer and M. McPhail. Pp. 155. (Washington, D.C.: Government Printing Office, 1944.) 35 cents. [222]

Annals of the New York Academy of Sciences. Vol. 45, Art. 9: Energy Relationships in Enzyme Reactions. By Joseph S. Fruton, Eric G. Ball, Max Bergmann, Herman M. Kalckar, Otto Meyerhof and Carl V. Smythe. Pp. 357-436. (New York: New York Academy of Sciences, 1944.) [272]

National Research Council. American Geophysical Union. Transactions of 1944. Part 1: Reports and Papers, Joint Regional Meeting, Section of Hydrology (South Pacific Area), Western Snow-Conference, American Society of Agricultural Engineers (Pacific Coast Section), Berkeley, California, February 17-18, 1944. Pp. 188. (Washington, D.C.: National Academy of Sciences, 1944.) 2 dollars. [272]

Carnegie Corporation of New York. Report of the President, the Secretary and the Treasurer for the Year ended September 30, 1944. Pp. 96. (New York: Carnegie Corporation of New York, 1945.) [272]

Department of Agriculture, Canada. Annual Report of the Forest Insect Survey Forest Insect Investigations, 1943. Pp. 68. (Ottawa: King's Printer, 1944.) [272]

Proceedings of the United States National Museum. Vol. 96, No. 3186: Review of the Spider Monkeys. By Remington Kellogg and E. A. Goldman. Pp. 46. (Washington, D.C.: Government Printing Office, 1944.) [272]

Catalogue

Hospital Physicists' Association: Diagrams and Data Subcommittee. Catalogue A: Being a list of Diagrams, Data, etc., of which copies can be supplied, and of Books (not easily obtainable) the loan of which can be arranged. (London: John Read, Hon. Secretary, Radiotherapy Department, London Hospital, E.1, 1944.) [272]