NATURE

No. 3932 SATURDAY, MARCH 10, 1945 Vol. 155

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MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.
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REHABILITATION OF EUROPEAN CULTURE

THE encouraging measure of agreement reached by Mr. Winston Churchill, President Roosevelt and Marshal Stalin at the Yalta meeting, as indicated in the communique issued on February 12, goes far to offset some of the doubts as to common policy which have arisen since the tentative proposals of the Dumbarton Oaks Conference were issued last October. Agreement has been reached on the difficult question of voting procedure in the Security Council of the new peace organization, and a Conference of the United Nations is to be called to meet at San Francisco on April 25, 1945, to prepare the charter of such an organization along the lines proposed at Dumbarton Oaks.

The declaration on liberated Europe is the most important of the three parts into which, apart from the military plans, the statement falls naturally. It is true that European policy cannot be sharply separated from the treatment of Germany, but without some common European policy and without the reconstruction of civil life and the full restoration of social, economic and cultural activity, in which science has a prominent place along with other intellectual activities, there can be no hope of any adequate solution of the German problem.

That problem will probably provide the most searching if not necessarily the first test of the adequacy of any new world organization, and it is the appearance of lack of harmony in the policy of Great Britain, of the United States and of the U.S.S.R. towards the liberated countries of Europe during the last six months that has given such a shock to public opinion. The three Governments—and the statement expresses the hope that the provisional Government of the French Republic may be associated with the three Powers in the procedure suggested—declare their mutual agreement to concert their policies, during the temporary period of instability in liberated Europe, in assisting the peoples of Europe to solve by democratic means their pressing political and economic problems. The establishment of order in Europe and the rebuilding of national economic life must be achieved by processes which will enable the liberated peoples to destroy the last vestiges of Nazism and Fascism and to create democratic institutions of their own choice. To foster the conditions in which the liberated peoples may exercise their sovereign rights and self-government, the three Governments pledge themselves to give joint assistance where required, in their judgment, to establish conditions of peace ; to carry out emergency measures for the relief of distressed peoples ; to form interim Government authorities broadly representative of all democratic elements in the population and pledged to the earliest possible establishment through free elections of Governments responsive to the will of the people ; and to facilitate, where necessary, the holding of such elections.

The declaration, which provides for consultation

with the other United Nations in Europe when matters of direct interest to themselves are under consideration, thus proposes to proceed from world order to peace, and though it may be objected that there are areas in Europe which are not yet ripe for democratic institutions, over a large part of liberated Europe this implementation of democracy should be effective and appropriate. Further, the second proposal—emergency measures for the relief of distressed peoples—is one that may well at once provide an effective means of education in democratic methods and the touchstone of the sincerity and determination of the three Great Powers subscribing to the Yalta Declaration.

There is in fact no question touched upon during the recent conference that is of more immediate concern to Great Britain than that of relief for the liberated countries of Europe. Grave anxiety regarding the relief of France has already found expression in the House of Commons and in the Press, and has not been dispelled by either Mr. C. R. Attlee's statement or the more recent one of Mr. Richard Law. The concern is shared by the troops serving on the Continent, and on all sides there is evidence that a more generous, imaginative and positive policy would be welcomed, and indeed is essential if the goodwill we found on the Continent is not to run to seed. The criticism of, and charges of grave weaknesses in, the United Nations Relief and Rehabilitation Administration which Dr. H. V. Evatt, leader of the Australian delegation, uttered at the opening session of the Conference of that body at Lapstone are in keeping with growing uneasiness which has been apparent since its council met at Montreal in September.

Much of the criticism that has been levelled against the United Nations Relief and Rehabilitation Administration may in fact be unjustified, for since the first session of its council met at Atlantic City in November 1943, a large organization has been built up and much information gathered about the needs to be met and the supplies available to meet them. So far, however, the actual relief work in the liberated areas of Western Europe has been done by the military authorities in conjunction with the French and Belgian Governments. Dr. Evatt argued from this that it was doubtful whether the Administration would perform all the duties intended under the terms of its charter, and urged that there must not be the same delays in the Far East that have occurred in Europe. Further, he said that administration was over-centralized and that wider national representation was needed at all levels of the administration and staff.

It is expected that U.N.R.R.A. may shortly be allowed to send supplementary supplies to certain countries, such as France, Belgium and Holland. This will involve a complete departure from the general principle of that body, that it will not operate in a country until invited to do so by the Government in power, and, in Western European countries who wish to pay for their supplies, until the relevant financial negotiations have been completed. While the new proposal releases the organization from the strictures that have in the past prevented it from dealing promptly with emergencies, it in no way affects the general schemes for providing relief in bulk in accordance with the original terms of the charter.

Though it is clearly unfair to blame U.N.R.R.A. itself for the present position, even given the limitations on its activities imposed by its charter, public opinion is not disposed to hold the Government entirely free from blame in this matter. Mr. Richard Law's statement in the House of Commons on February 13 with reference to relief appeals for allied and liberated countries will not allay misgivings on this point, for it showed lack of insight and imagination. His statement on February 14 on the economic and supply position in the liberated countries of Western Europe, while satisfactory so far as it went, did not remove the impression that the military authorities, to whom the matter had been left, have not shown sufficient foresight. The main failure, Mr. Law said, has been in distribution, but the national governments cannot be held entirely responsible because not only were the means of transport lacking but also the administrative machine had become seriously impaired and had to be rebuilt. No one will deny that the first objective of the military authorities must be to wage war and to wage war effectively, or that the requirements of our liberated allies are in direct competition with urgent military demands. Equally it cannot be denied that the position is one where high policy is also involved, and where the Government cannot evade the responsibility for rapid and decisive action.

What appear to be lacking are the imagination and warmth of sympathy already evident in public opinion. There is in the Government's statements no appreciation of what might be the effect of announcing that we were to release, for example, some of our own ample stocks of fats for France and Belgium, where the deficiency is so great. It is not yet forgotten in Europe that Mr. Churchill, when Secretary of State for War in 1919, not only opposed the continuance of the blockade of Central Europe as endangering a collapse of the entire structure of German social and national life, but also had earlier sought on Armistice Day to send six food ships to Hamburg. It is all a matter of the right priorities. We have large reserves of many other foodstuffs which were regarded as essential when the climax of the War still seemed distant but which could be safely reduced now. Even a reduction of food rations in Britain might be considered for the critical few weeks, provided that the urgency were explained fully to the people.

What is most essential is a clear understanding of how dangerous the alienation of France may become, and of how urgent it is not merely to meet the need but also to seize the chance to restore France. When that is realized there can be no hesitation over the decisions to be taken to divert transport from the more obvious military needs to the more urgent but no less vital needs of the political and economic

warfare against the same enemy. Here, as throughout the War, has been the weakest spot in our strategy; the rapid reconstruction of Europe is in fact not merely the background against which all relief work, whether through the United Nations Relief and Rehabilitation Administration or not, should be viewed, but also an essential condition of victory, without which military success may be sterile.

Nor should it be imagined that relief and reconstruction have physical or material aspects alone. The reconstruction of France and of Europe is a cultural and spiritual task also. Even now, six months or more after the liberation of France and Belgium, cultural contacts have scarcely been established except in the most desultory manner. Import of French books has not yet been resumed, and the Government's own policy with regard to paper for books removes all hope at present of providing France with the British scientific and other books which she awaits. Without such interchange and collaboration there cannot come the full understanding between the two great Western democracies which must be a prelude to their closer co-operation in the reconstruction of Europe, in whatever form that may ultimately take.

The abatement of national prejudice and passion, and the mutual sacrifices which are involved in building any form of world order, will not be made in moments of sentimental impulse. They will arise out of a clear understanding of what is involved and the deliberate surrender of the lesser to the greater ideal. That is the substance of Prof. D. Mitrany's argument in "The Road to Security"*. He sees the only basis of security in positive and constructive action in the social and economic fields. An international organization cannot limit itself to the negative purpose of restraining aggression: in a world of change, it must also help to bring about constructive change.

Prof. Mitrany, in this little pamphlet, brings out very clearly the relation between national planning and world order. International peace cannot be considered as consisting only in the prevention of violence. We must take account of social unity and economic development, and it was the failure to do this that broke the system of common order represented by the League of Nations. If once more we conceive of security as merely a matter of policing the world against the use of violence, we may well find divisions in the economic world—competition in shipping and aviation, for raw materials and trade—even more acute than during the twenty years of truce. Even the aspirations for full employment and social security, with the national planning and State action involved, may threaten security unless national planning is geared from the outset to international planning.

In fact, the organization envisaged at Dumbarton Oaks will be futile, Prof. Mitrany believes, unless we develop joint economic arrangements sufficiently comprehensive and far-reaching to prevent a split between the participating Powers. Such arrangements would go far towards protecting States, especially the economically weak States, from economic aggression, and remove the temptation to try aggression for economic and social ends. Moreover, certain agencies are already available for that purpose, as Prof. Mitrany points out, and as is further indicated in the P E P broadsheets which have been brought together and re-issued under the title "Building Peace out of War". Economic technical agencies would be preventive, by their very nature, in a way in which military agencies never can be. Just as it would be their function to give service wherever it is needed, so it would be their duty to deny service where it is not obviously needed and might be abused.

Stress is laid by Prof. Mitrany on this withdrawal of services as an effective form of sanctions, but the most important point is undoubtedly that they are a step towards dealing jointly and resolutely with the very springs of war. The real problem of security and the task of statesmanship are not to keep the nations peacefully apart, but to bring them actively together, and in such a task science has an essential part to play. As is pointed out in the P E P broadsheets, in building European unity, parallel with the establishment of a framework of order and security must go the reconstruction and development of European life in the direction of a social, economic and cultural community which all its citizens have a common interest in maintaining and furthering, and to which all will eventually come to feel a loyalty commensurate with their loyalty to their own countries. Moreover, the key to the restoration of social stability will be the rebuilding and development in new forms of those cultural and other institutions and associations which are the life-blood of a free community, but have been persecuted or suppressed by totalitarian Germany—universities, churches, trade unions, professional organizations, the free Press and radio.

Linked with the rebuilding of institutions is the gradual development of individual leaders in every sphere, and here the emphasis must be on individuals, not governments, for in a Europe functioning as a community the individual leaders of industries, trade unions, universities and other vital institutions are as important as those of regional governments. In such a process the universities of Europe, which inherit the tradition of European unity, must take a central role, whether or not there is linked to them, as is suggested by P E P, as centres of post-graduate training and research, one or more special European staff colleges for the training of Europe's key administrative personnel.

There can be no doubt that, as is stated in the final study of this volume, the people of war-ravaged Europe will look to Britain for help and guidance in picking up again the scattered threads of the European tradition, and in rebuilding the institutions in which it is largely embedded. But since that broadsheet was written in 1943, the problem and the task have

* The Road to Security. By Prof. David Mitrany. Pp. 20. (Nat. Peace Council, 144 Southampton Row, London, W.C.1, 1944.) 4d.

become urgent and imperative. The situation is desperate, and it is no longer merely a matter of urging that the advance of science demands the resumption of normal free communication and contact the moment military exigencies permit: it is rather that unless the physical task of relief and reconstruction is undertaken forthwith, military success may be sterile. Even now the physical task demands all the help and inspiration it can draw from the cultural life and the institutions which enshrine the tradition of European unity and the highest ideals of its intellectual and spiritual life.

It is in fact a moral obligation that rests on scientific workers to press for the re-establishment of contacts with their colleagues in liberated Europe, and to co-operate with them in building up once more the tradition and institutions of learning and research which Germany has sought to extirpate. The task of reconstructing the universities of Europe is immense, and in the physical sphere little may yet be practicable. But already the planning of such reconstruction is an urgent task, and a generous response to the desperate needs of Europe on the part of scientific workers, no less than of other men of learning and culture, might have an immense effect in establishing an atmosphere of understanding and goodwill and in giving new hope. What are required above all are vision and imagination to sense the possibilities, as well as the dangers, and to grasp the significance of the European cultural contacts and institutions which the Committee on Intellectual Co-operation once represented, not merely in providing the leaders required to-morrow, or in establishing the freedom of thought, of utterance and of investigation, but in creating that sense of European community of interest, of confidence, which brings fresh hope, in place of frustration or despair, and without which the sore-pressed peoples of Europe might have no heart to address themselves to that task of reconstruction.

BOTANY IN BRITAIN

British Botanists

By John Gilmour. (Britain in Pictures Series.) Pp. 48+8 plates. (London: Wm. Collins, Sons and Co., Ltd., 1944.) 4*s*. 6*d*. net.

THE history of science has for so long been written from the point of view of chemistry and physics, with generous recognition of astronomy and even geology, but with almost complete indifference to biology in any form, that it is encouraging to note the recent development of interest in the records of early botanists and zoologists. A brief and accurate history of British botany, written with the knowledge that the late Dr. Gunther on one side and Dr. Agnes Arber on the other have made available to us, is a very valuable help to such development. Mr. John Gilmour's book is excellent and timely.

To survey a history which covers four such changeful centuries; to tell the story of so large and so varied a succession of students; to keep a sense of proportion so that the outstanding developments of the science are not lost in a mass of detail; and to present the story with all its human interest and charm and excitement as a fascinating adventure; this fourfold task Mr. Gilmour has discharged with eminent success. There are inevitably gaps, particularly perhaps in the early stages of the story: the present reviewer would plead for recognition of Thomas Penny, the friend of De l'Obel and De l'Ecluse and chief author of the "Theatrum Insectorum", and of Thomas Willisel, the first professional field-naturalist, employed by Merret and then by the Royal Society, and the discoverer of many of our rarer plants, particularly in the Pennines and Teesdale. But to compress the record into forty-eight pages, many of them half-filled with pictures, is necessarily to cut it down to the barest skeleton. That Mr. Gilmour has nevertheless found room for such delightful descriptions as that of Stephen Hales' Sunday at Teddington and for clear hints as to the relationship between botanical studies and the general ideas and culture of the time is proof of real skill as a writer as well as real knowledge as a historian. We notice only one slip in matter of fact: Bilson, not Bilster, is the name of John Goodyer's employer on p. 13.

The book, like others of the series, is almost lavishly illustrated, and here too Mr. Gilmour has chosen his pictures with discrimination. They cover a very wide range of subjects, are representative of different aspects and moments of the story, and thus are a real contribution to the record.

It is much to be hoped that Mr. Gilmour will carry on with work in this field. There is no satisfactory history of botany, and few subjects supply more abundant and more interesting material. He has evidently got a thorough knowledge of very much of what is generally available, and possesses the threefold qualification—a thorough knowledge of botany, an understanding of historical method and research, and the power to write vividly and accurately. We hope that the success of this small essay will encourage him to a large-scale work.

C. E. RAVEN.

REJUVENATION OF PLANT GEOGRAPHY

Foundations of Plant Geography

By Prof. Stanley A. Cain. Pp. xiv+556. (New York and London: Harper and Brothers, 1944.) 5 dollars.

IN a recent review of "Historical Plant Geography" by the late Prof. E. V. Wulff[1], reasons were given for thinking that the subject had been revitalized by the recent application to it of methods and information developed and acquired in other scientific fields. It now appears that while these changes were leading Prof. Wulff to write his book in Leningrad, they had, in the United States, caused Dr. S. A. Cain similarly to set about accumulating material for this comprehensive volume on "Foundations of Plant Geography".

Though both works convey the indication of the opening of a wide territory for scientific investigation, they differ considerably in scope and emphasis. Prof. Cain's book is conspicuous for its reference to a very large body of work by the great American phytogeographers, such as Asa Gray, Fernald, Marie Victorin and Gleason, with their very numerous and able followers. One cannot indeed help the reflexion that the North American continent has offered, and still does offer, greater advantages to the plant

geographer than any other continental area. The circumstance was long ago pointed out that the mountain-range direction from north to south did not hinder the great vegetational movements made under compulsion of the climatic shifts of the Ice Age, and there now persists a tremendously rich flora distributed in patterns the meaning of which we at last begin to glimpse.

Among the most striking resolutions achieved so far we may mention (1) the per-glacial survival of species described by Fernald in the Gaspé peninsula and equivalent areas, (2) the work of Miss Lucy M. Braun to demonstrate the preservation of Tertiary mixed forest in the southern Appalachians, and the differentiation and migration of later vegetation types therefrom, (3) the history of migration and evolution of the genus *Vernonia* in the south and east of the United States worked out by Gleason, and (4) the remarkable history of western American forest types established by Chaney and Mason from fossil and distributional evidence throughout the Cenozoic period.

Nowhere has the study of genetics and its application to the problems of the mechanism of speciation been given more enthusiastic attention than in the United States, and Dr. Cain's book is characterized (in contrast with that of Prof. Wulff) by a sustained attempt to clarify the relation between modern cytogenetics, evolutionary theory and problems of plant distribution; indeed, about half the book is occupied by discussion of topics in this field. It is evident that the phenomena of speciation are so distinctly concerned with genetic isolation, which itself is closely correlated with geographic isolation, that progress in knowledge of evolution and of phytogeography alike demands an increasingly critical investigation of the distributional data of plant populations. The recognition of this situation makes great demands (as it presents great opportunities) to the modern plant geographer. He may not assume that the 'species' of taxonomists, his chief working material, are by any means equivalent in status or origin, he must not assume that the first-described species type is necessarily the basic form from which later-described varieties are derivative, and he must always be prepared to submit his collected material to intensive genetic and cytological analysis.

The way in which Dr. Cain attempts to integrate the cytogenetic approach with recent knowledge of geological and climatic history can be illustrated by a quotation (p. 432): "In such a region, especially after glacial recession has commenced, there are numerous new, variable and closely associated habitats in which populations of a variety of species can live in rather close proximity. The result of this intermingling of species may be the production of hybrids, followed sometimes by amphidiploidy. With continued glacial recession, the polyploids and back-crosses are in a position to expand their area tremendously. Some of the diploids also may extend far on to the glacial plain, but most of them will probably have only limited expansion. The chances of such polyploids spreading into unglaciated territory to any considerable extent seems unlikely because penetration of closed communities is more difficult."

The reality of such a mechanism as this remains to be established, like that of so many hypotheses for similar distributional and evolutionary situations; but it will be apparent how usefully the book directs attention to the considerable progress recently made in definition of problems and recognition of new approaches.

We may note a few incidental features of general interest which indicate the progress of phytogeographic ideas in the last decade or two. General opinion is shown to have swung over (partly as a result of the teaching of Willis) from regarding endemics as relict, to regarding them in many instances as recently evolved; it is now said that "some geographers believe in the efficacy of long-distance dispersal for many types of organisms, but the weight of evidence in most cases seems to be strongly opposed to such an assumption"; centres of preservation of plants throughout the ice age are freely accepted to have occurred even in northern territories.

Prof. Cain is well aware that in attempting to synthesize the results of many sciences he lays himself open to attack from the specialists in all of them. We shall here only give a single general and constructive criticism. It is stressed that there is necessity for migration of biotypes into new areas if there is to be reasonable chance for new ecotypes to arise. Geographers and ecologists may easily overlook that the habitat may, so to say, migrate to the species, rather than the other way round. By this I mean that we should view plant populations, not as living under stable conditions, but against a background pattern of ceaseless climatic change, with small seasonal shifts at one end of the scale of frequency and amplitude, and glacial epochs at the other. Especially if this alteration affects a topographically varied territory, there is then little need to invoke migration to precede the differentiation of ecotypes.

The section headings will convey the content of the book: (1) Introduction; (2) Palæoecology; (3) Areography (that is, distribution patterns); (4) Evolution and Plant Geography; (5) Significance of Polyploidy in Plant Geography. There are an immense bibliography and a useful glossary.

H. GODWIN.

[1] *Nature*, **152**, 490 (1943).

MEASUREMENT OF COLOUR

The Measurement of Colour

By Dr. W. D. Wright. Pp. vii+223. (London: Adam Hilger, Ltd., 1944.) 30*s*. net.

A BOOK by Dr. W. D. Wright may confidently be expected to be first class, and the present publication is ample justification for such a prophecy. Colorimetry depends mainly upon classical physics for most of its theory, and luckily the conceptions involved are to some extent quasi-mechanical, which is probably the reason why applications to industry and technology have been both rapid and successful. The reviewer's task may thus best be implemented by discussing some of the more important of these developments in the light of the guidance afforded by the volume before us. Before so doing, however, there are a few features of wider significance. One is the way in which the fundamental character of certain optical instruments and processes is laid bare; for example, the additive trichromatic colorimeter, the photo-electric tricolorimeter and the three-colour process of colour reproduction. The reader can see from the diagrams exactly what functions must be fulfilled, unmolested by photographs or descriptions of particular types of apparatus. Incidentally, what searching examination questions these topics would provide: to describe simply and directly the necessary and sufficient conditions that the required ends

(often very involved) may be achieved. It would certainly not be easy to do it better than it is done here. Something of the kind found a place in the best German books of the nineteen-twenties, but they lacked the stimulus to deep comprehension on the reader's part which Dr. Wright has managed to introduce.

Another question treated with unusual clarity is that of the human retina, especially from the point of view of Polyak's work (1941). This leads naturally to a comparison of the wave-length and relative luminosity positions of the scotopic (low brightness) and photopic (high brightness) curves, the former for rod (monochrome) vision, and the latter for cone (coloured) vision. Artists and the like are well aware, empirically, of the darkening of red surfaces with diminishing illumination, a species of Purkinje effect for which the relative displacement of the scotopic curve towards higher frequencies is responsible. Although perhaps not directly concerned, psychologists will read this portion with interest, since implicit in these energy relations is supposedly the nature of the connexion between 'fact' and 'correlate'. It may well be that the useful, though problematical, concept of isomorphy will be unable to stand up in its present form against increasingly exact knowledge of retinal reactions. There are other complications, no doubt, but a better biophysics of colour-vision is evidently on the way.

Now for some of the applications. Many industrial matters demand the fixing of minute colour differences rather than absolute 'norms'. The Hardy spectrophotometer is excellent here, since much of the work may be concerned with reflexion, where the accuracy is most favourable. I have witnessed Hardy's machine at work upon reflectance measurements of specially prepared artists' pigments. Even allowing for somewhat elaborate calibration and checking, the speed at which the curves could be constructed was remarkable. As Dr. Wright points out, one must not cavil at Hardy's inability to cope perfectly with fluorescence or specular reflexion, since these troubles are inseparable from the system. Nevertheless, the latter component can now be wholly included or wholly excluded, thus removing uncertainty. It is characteristic of the author's practical attitude that he adds a number of methods, more or less approximate, applicable to cases where complete spectrophotometry would not be justified. Much can be done by these means, so long as the absorption wave-length curve does not change direction too abruptly.

A chapter is devoted to colour atlases. These common adjuncts clearly suffer from the disadvantages of being incapable of supplying more than a fraction of all discernibly different colours and, moreover, they fade and get dirty. Nevertheless, they have their uses, as Dr. Wright explains. An interesting forecast is that we might "in, say a hundred years' time", be able to do our colour matching and selection by means of the tristimulus values, X, Y, Z, alone. Meanwhile, we are driven by some psychological urge to ask for a pattern, transient as it may be. Musicians say they can appreciate perfectly a melody by reading the score; it is hard to see why artists should not do likewise some day, and obtain colour-harmony from the appropriate algebra.

Several other intriguing outlets for colorimetry follow: chemicals and their mixture, lighting, agriculture, pulp, paper and paint, signal glasses, photoelasticity and so on. In fact, their name is legion; and as if to practise what is preached, several excellent coloured charts are included, some quite novel, and all of them helpful.

The price is the crux: for what is little more than a manual, thirty shillings does seem excessive. One would like to imagine a student reading this book time and time again; but if he does, he will probably have had to borrow a copy from somebody else.

F. IAN G. RAWLINS.

INTERACTIONS OF HEREDITY AND ENVIRONMENT

Livestock Improvement

In Relation to Heredity and Environment. By Dr. J. E. Nichols. Pp. vii+208+7 plates. (Edinburgh and London: Oliver and Boyd, 1944.) 10*s*. 6*d*. net.

THIS book, as the author says, attempts to outline the principles and to indicate how the genetic and environmental concepts are interwoven in the idea of livestock improvement. Much original work is included in the book, especially work on problems of sheep-breeding drawn from personal observations in many different countries.

In addition to an outline of the principles and details of genetics as applied to the breeding of farm animals, other factors closely linked with genetics and affecting livestock improvement are dealt with—such as environmental aspects, type and environment, and breed construction. These latter chapters indicate some of the problems which the applied animal breeder as distinct from the pure geneticist has to take into account. Here the idea of evolution as distinct from the modern analytical aspects of genetics creeps in, and the facts given may provide a means of bridging the gap between the ideas of Darwin and of Mendel, or between those of Lysenko and Vavilov. In particular, Nichols' conception of the stratification of the sheep industry in time and space provides the palæontologist and zoologist with a concrete example of what has occurred, and is occurring, in the evolution of a species, or in the evolution of the fauna in a district. The agriculturalist's aim to control and change environmental conditions is from the zoologist's point of view a grand experiment in the evolution of animals. Throughout the book there is a number of references to work done in tropical countries; these should provide a basis for the development of the animal industry in British Colonies and other tropical countries.

The chapters on gene and character frequency, inbreeding, outbreeding and hybrid vigour, and performance and progeny testing should prove most useful to the practical breeder of livestock, as they will enable him to see how the modern science of genetics can be usefully employed to effect a short cut to his objectives. The formulæ given in several places may prove somewhat difficult to practical breeders, but they are reduced to the minimum that is necessary for proper comprehension by a student of the subject.

The book is packed with information concerning farm animals, well illustrated and has an extensive list of references to which the reader can go for further details. With government policy giving encouragement to the better breeding of farm animals, this book should meet a widespread demand from students, teachers and breeders for more information on the methods of livestock improvement.

JOHN HAMMOND.

CAUSALITY OR INDETERMINISM?

By PROF. H. T. H. PIAGGIO
University College, Nottingham

A SHORT article published in *Nature* of July 22, 1944[1], entitled "Collapse of Determinism", contained a brief statement of von Neumann's claim to have demonstrated that the results of the quantum theory cannot be obtained by averaging any exact causal laws. If one may judge from the number of communications referring to this point which have been submitted to the Editors, many regard this claim with suspicion and desire a more detailed discussion of the grounds on which it is based. Mr. W. W. Barkas[2] suggested that the existence of statistical regularity when large numbers of events are considered is incompatible with indeterminism, and that if the final result of the behaviour of a million photons were fixed, the behaviour of the first 999,000 must influence the other 1,000. Prof. (now Sir Edmund) Whittaker[2] replied that it might be profitable to consider the behaviour of tossed coins. He asked, in particular, whether the statistical regularity for this case, calculated by the ordinary theory of probability, involves the assumption of 'crypto-determinism' (that is, real determinism hidden by lack of detailed information) or merely the assumption of symmetry. This reply produced further letters, too numerous for the Editors to publish in full, and I have been asked to give a connected account of the points raised. I shall start with the experimental evidence concerning coin-tossing, and contrast it with the theoretical discussion. After this I shall touch upon similar considerations for the kinetic theory of gases. Finally, and most important, I shall give some details of von Neumann's supposed disproof of causality, and give the arguments for and against it.

Buffon, the French naturalist, tossed a coin until he obtained 2,048 heads. The results were quoted by De Morgan[3], who gave also an account of three similar experiments by his own pupils or correspondents. The arrangement by which the last toss ended with a head gave a small advantage to heads, but too small to make any significant difference. Much more extensive experiments, on somewhat different lines, were carried out by W. S. Jevons[4], who took "a handful of ten coins, usually shillings", and tossed the ten together. He made two series of 1,024 such tossings of ten coins, so that in each series 10,240 coins were tossed. The results of these six experiments were as follows :

No. of heads ..	2,048	2,048	2,048	2,048	5,222	5,131
No. of tails ..	1,992	2,044	2,020	2,069	5,018	5,109
Total	4,040	4,092	4,068	4,117	10,240	10,240
Excess of heads over mean ..	28	2	14	−10·5	102	11
Proportion of heads ..	0·5069	0·5005	0·5034	0·4974	0·5100	0·5011
Excess over mean ..	0·0069	0·0005	0·0034	−0·0026	0·0100	0·0011

If we examine these results, we see that it is easy to misinterpret the meaning of 'statistical regularity'. It is certainly not true, as some correspondents seemed to think, that the numbers of heads and tails are bound to be equal. In fact, the divergence from the mean actually increased from a maximum of 28 in the first four experiments, each based on roughly 4,096 tosses, to a maximum of 102 in the last pair, each based on 10,240 tosses. This is quite in accordance with theory, which, assuming that the probability of a head in one toss is 0·5, deduces that for a large number n of tosses, it is as likely as not that the divergence from the expected mean $n/2$ will exceed $0{\cdot}3372\sqrt{n}$, but it is almost certain (99·73 per cent probability) that it will be less than $1{\cdot}5\sqrt{n}$. For $n = 4{,}096$ the 'as-likely-as-not divergence' is, to the nearest integer, 22, and the 'scarcely-ever divergence' is 96. For $n = 10{,}240$, the corresponding numbers are 34 and 152. Thus the actual divergences, though larger and more one-sided than some might have expected, are quite compatible with the theory. But the phrase 'statistical regularity' really refers to the *proportion* of heads, which, according to theory, should be very nearly 0·5, with an 'as-likely-as-not divergence' of $0{\cdot}3372/\sqrt{n}$ and a 'scarcely-ever divergence' of $1{\cdot}5/\sqrt{n}$. Both these divergences diminish indefinitely as n increases. We may also estimate the theoretical divergence of the proportion by its root-mean-square or 'standard deviation'. This has the value $0{\cdot}5/\sqrt{n}$, a result which we shall contrast later with Heisenberg's Principle of Uncertainty.

We now come to an important criticism of the theory of probability on which the above calculations are based. As pointed out by Lieut.-Colonel E. Gold[5], there is an assumption of symmetry, not only in the two faces of the coin, but also in the actions of the hand that tosses the coin. When the hand was replaced by a machine, such as that devised by J. Horzelski[6], the absence of this symmetry was manifest. By a certain adjustment of the pressure actuating a lever, he obtained 98 heads out of 100 tosses. He then slightly altered the pressure, keeping the head, as before, initially upwards on the machine, and obtained only one head in the next 100 tosses. In this case the tossing mechanism is not a hidden parameter, but is visible and definite, whereas in the usual tossing it is indefinite and, so far as we can manage it, symmetrically distributed. It is possible that the excess of heads in Jevons's experiments was due to some slight lack of symmetry in his tossing conditions. Whether this was so or not, it appears obvious that *the description of reality given by the theory of probability in coin-tossing is not complete.*

It is therefore erroneous to suppose that the properties of a perfectly normal distribution must necessarily correspond exactly with physical reality, however useful they may be in giving a good approximation to the facts. We cannot disprove the existence of the details of the projection merely by claiming that they upset the purity of the normal distribution. It is rather the very purity of that distribution which goes beyond the physical facts, and so is not a complete description of reality. Similar considerations apply to the kinetic theory of gases, but in this case the symmetry assumed in the theory[7] is a much closer approximation to the actual facts. But it is only an approximation, and here, as elsewhere in classical physics, pure statistical aggregates do not exist.

This brings us to the question whether such aggregates exist in non-classical physics, in particular in quantum mechanics. We shall examine von Neumann's arguments, using for this purpose not only his well-known treatise "Mathematische Grundlagen der Quantenmechanik" (1932), but also the shorter account, in English, that he gave in Warsaw[8] in 1937, and the discussion that ensued. The starting point is an analysis of the qualitative laws obeyed by the mathematical 'hypermaximal projective' operators which correspond to the physical quantities occurring in quantum mechanics. Everything is said to be based on six laws, of which two seem more

important than the rest. One is the principle of superposition, extended to quantities not necessarily simultaneously measurable. The other may be called the principle of exact functional correspondence; for example, if an operator represents a physical quantity, then the square of the operator represents the square of the quantity.

In my opinion, however, the emphasis on these simple laws conceals the fact that other conditions of greater importance are imposed by the definition of 'hypermaximal projective' operators. This definition implies some characteristic results of quantum mechanics, and the simple laws are merely the final requirements. Von Neumann shows that aggregates are of two kinds, 'pure' and 'mixed'. The essential property of a pure aggregate is that it cannot be regarded as a mixture of two other non-identical aggregates. The qualitative laws of quantum mechanics show that the aggregates concerned must be pure, whereas all aggregates based upon causal laws, such as tossed coins or gas particles, must be mixed. Hence, he concludes, causality is incompatible with quantum mechanics, and the process of averaging causal laws, as applied in the kinetic theory of gases, cannot possibly be extended to quantum mechanics. There is no need, he says, to go more deeply into the details of a supposed system which is governed by further conditions ('hidden parameters') in addition to the wave functions. These hidden parameters would upset the qualitative laws of quantum mechanics. He admits that quantum mechanics in its present form is certainly defective, and, in spite of its great success in explaining physical phenomena, may possibly, in the long run, turn out to be false. But this is true of every theory; we can never say that it is proved by experiment, but only that it is the best summing up of experiment at present known.

Von Neumann therefore concludes that there is at present no reason and no excuse for supposing the existence of causality in quantum mechanics. This conclusion is described by Whittaker[9] as not only novel and unexpected, but also almost incredible, yet he endorses it with the exultant declaration "the bonds of necessity have been broken; for certain classes of phenomena, crypto-determinism is definitely disproved".

Other comments have been more sceptical. At the Warsaw conference, the president, C. Białobrzeski, after hearing von Neumann, admitted the validity of the argument that it was impossible to fit causality into the framework of quantum mechanics, but expressed a doubt as to the logical coherence of that framework. In his opinion it is deficient because it does not take account of irreversible changes, and also because, in certain conditions of measurement, the indeterminism of the final state disappears, and the assumptions of discontinuity and indeterminism do not correspond to reality. He thought it necessary to introduce a new postulate concerning measurement. At a later meeting of the same conference a letter from Heisenberg said that the quantum theory, in its present form, could not yet give a logically coherent account of nuclear physics or of cosmic rays.

Many critics are suspicious of purely abstract arguments which make no reference to experiment. Of course, such experiments as those of Davisson and Germer on electron diffraction and of Condon and Gurney on radioactivity, though excellent as illustrations of the Uncertainty Principle, yet have no value in deciding whether this uncertainty is due only to lack of detailed knowledge, or to true indeterminism. On a somewhat different plane is the argument of Whittaker[9], who, though a supporter of von Neumann, illustrates his argument by a reference to the passage of plane-polarized light passing through a Nicol prism, and shows that the phenomena cannot be explained by causal laws governing any hidden parameters attributed to the photons. However, H. Pelzer[10] gives two models in which hidden parameters, attributed at least partly to the Nicol prism, can exist and obey causal laws. From this he infers that the arguments of Whittaker and von Neumann are incomplete, even though he agrees with their conclusion that quantum phenomena are truly indeterminate.

My own criticism of von Neumann is founded upon a paper by A. Einstein, B. Podolsky and N. Rosen[11]. By considering the problem of making predictions concerning a system on the basis of measurements made on another system which had previously interacted with it, they conclude that *the description of reality as given by a wave function is not complete*. As a wave function is a mathematical way of representing a probability distribution, this conclusion is almost exactly the same as that which I enunciated concerning coin-tossing. I therefore, with great diffidence, offer the opinion that the existence of causality has *not* been disproved. It is true that Einstein's opinion has been rejected by N. Bohr[12], but there are other grounds for supporting it. In fact, the postulate of quantum mechanics that electrons cannot be distinguished from one another appears, at least to me, not to be a statement that Nature is incomprehensible, but merely that quantum mechanics is incomplete. However, I do not wish to insist that there is no difference between coin-tossing and quantum mechanics. One striking difference is that in coin-tossing the standard deviation of the proportion of heads depends only upon the number of tosses, and can be diminished indefinitely; but in quantum mechanics the Principle of Uncertainty gives for the product of the standard deviations of the momentum and displacement a minimum value, namely, $h/4\pi$. The occurrence of Planck's constant in this result seems to show that there is something essentially new. I should find it easier to accept von Neumann's conclusions if his arguments, instead of being purely qualitative, contained this constant. Perhaps it is really concealed somewhere in the background, like a hidden parameter!

To conclude, I will quote the opinion expressed by Bertrand Russell[13] in 1936, that at present there is no decisive reason in favour of complete determinism (causality) in physics, but that there is no reason against it, and that it is theoretically impossible that there should be any such reason. But Russell does not mention von Neumann's arguments. My own conclusion is that the balance of the present evidence is rather against complete causality, but that the question is still unsettled.

1 *Nature*, **154**, 122 (1944).
2 *Nature*, **154**, 676 (1944).
3 "Budget of Paradoxes", 170 (1872).
4 "Principles of Science", 238 (1874); or 2nd ed., 208 (1877).
5 *Nature*, **155**, 111 (1945).
6 *Nature*, **155**, 111 (1945).
7 Preston, "Theory of Heat", 4th ed., 782 (1929).
8 "New Theories in Physics", 30–45.
9 *Proc. Phys. Soc.*, **55**, 459 (1943).
10 *Proc. Phys. Soc.*, **53**, 195 (1944).
11 *Phys. Rev.*, **47**, 777 (1935).
12 *Phys. Rev.*, **48**, 696 (1935).
13 *Proc. Univ. of Durham Phil. Soc.*, **9**, 228 (1936).

CONSTRUCTION OF THE SHOOT APEX IN CEREALS AND OTHER GRASSES

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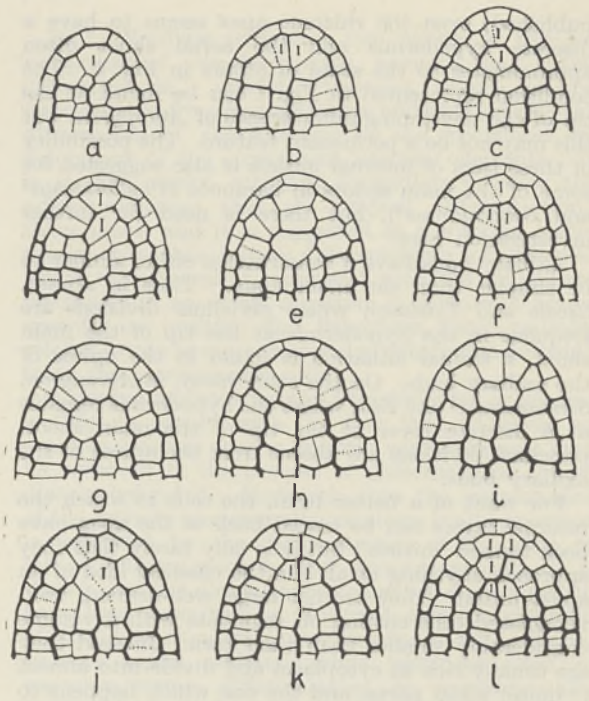
THE reawakening of interest in the developmental anatomy of the shoot apex has been paralleled by considerable advances in technique and by a growing realization that the answers to many genetical problems are locked up in a better understanding of the processes at work during the ontogeny of the organism. For a number of reasons, our knowledge of apical architecture is, so far, most advanced in the Gramineæ: here we are now in the happy position of realizing that much of the early controversy arose, not from incorrect recording of facts, but from the participants failing to realize that they were dealing with separate chapters of the same story. Although all members of the family probably conform with the scheme set out in the present résumé, for convenience reference is mainly made to species already discussed in the literature.

In the Gramineæ, the apex is always a comparatively elongated structure, with the cells at the extreme tip rather larger than those in the zone of leaf initiation and with less easily stained nuclei and a suggestion of being more vacuolated. The outer cells form a single thimble-shaped layer—the dermatogen—and normally only divide anticlinally. They may sometimes originate from a single ill-defined apical 'initial', but more usually come from an even more indefinite group of 'initials'.

At the extreme tip it is often difficult to determine the arrangement of the internal cells, but a short distance back they are always found to be arranged in at least a hypodermis and sub-hypodermis, each one cell thick, which form concentric shells clothing a core of more vacuolated, less rapidly dividing tissue of a sort of 'apical pith'.

The dermatogen, hypodermis and sub-hypodermis maintain their individuality because the cells forming them divide only by anticlinal walls until a new leaf is initiated. Then successive periclinal divisions occur in the cells of the dermatogen and hypodermis, while the cells of the sub-hypodermis under the insertion of the new primordium only divide periclinally once. On the other hand, at the origin of the axillary bud the sub-hypodermal cells repeatedly divide periclinally; but those of the dermatogen, and usually the hypodermis also, only divide anticlinally.

The inner cells may originate in a variety of ways. In young seedlings and perhaps throughout most of the vegetative life of some slender grasses, they can all be traced back to a single 'segmenting' apical cell as in Fig. *a*. Sometimes (Fig. *b*) more than one apical cell is present, when the segments cut off produce the inner tissues as they are left behind. In both these types the first products of division of the one or more initials immediately divide once periclinally to give a cylinder (the hypodermis) one cell thick surrounding a core at first two cells in diameter. In older or more massive shoots there may be two superimposed initials (Fig. *c*), one giving rise to the hypodermis and the other to the rest of the internal tissue. Occasionally the situation in Fig. *d* occurs, where the inner initial cuts off cells to one side only, and these immediately divide once (the outer cell giving the hypodermis of that side), while the upper initial cuts off cells destined on one side to be the hypodermis but on the other side to divide periclinally once, the outer cell becoming a hypodermal cell. These four types are those reputed to be usual for *Avena*[1], *Secale*[2] and *Triticum*[2] during their vegetative period, although even here a periclinal division in the 'initial' cell of the hypodermis every now and then leads to the displacement backwards of the old inner initial and its subsequent loss by differentiation (Fig. *e*). In other grasses, at least, apices can be found where there is a single 'initial' for the hypodermis and two or more for the central tissues (Fig. *f*). Here again an occasional periclinal division in the hypodermal initial leads to the displacement of the inner initial as in Figs. *g*, *h* and *i*. Fig. *h* also suggests a possible method of origin of apices of the more complex type seen in Fig. *j*, where there are two or more 'initials' for the hypodermis overlying a single one below. Similarly, Fig. *i* suggests a mode of origin of the more massive type of apex shown in Fig. *k* with two or more hypodermal initials and two or more initials below.



Progressively during ontogeny the apex usually tends to possess more initials, and the hypodermis tends to have an initial or initial group of its own superimposed upon the initial or initial groups of the more central cells. Although in the more massive types the hypodermis undoubtedly behaves as a distinct self-perpetuating layer for considerable periods, occasional periclinal divisions at the extreme tip may probably occur at any time and so lead to the displacement of the initials below. Not all species have apices of the same complexity at comparable times in their developmental history leading to inflorescence production. Thus, for example, although *Avena*[1], *Secale*[2] and *Triticum*[2] may have a separate initial or initial group for the hypodermis towards the end of the vegetative period, this only becomes a permanent feature from the time of inflorescence initiation, while in *Agropyron repens* Beauv. (un-

published) even the rhizome apex seems to have a discrete hypodermis and the aerial shoot often approximates to the state of affairs in Fig. *k*. The condition represented in Fig. *l* can be found at the tip of the developing inflorescence of *Agropyron*, but this may not be a permanent feature. The possibility of three tiers of internal initials is also suggested for some of the main shoots in bamboos (*Phyllostachys*[3] and *Sinocalamus*[4]), but there is need for further investigation here.

Axillary buds have a construction either similar to or simpler than the main apex. Thus in *Avena*, *Secale* and *Triticum*, where periclinal divisions are frequent in the hypodermis at the tip of the main shoot, a similar situation is found in the apices of the axillary buds. On the other hand, in *Agropyron*, *Sinocalamus*[4] and *Zea*, where the hypodermis remains as a discrete layer at the tip of the main shoot, periclinal divisions are absent from the apices of the axillary buds.

For want of a better term, the cells to which the internal layers can be traced back in the apex have been termed 'initials', but it is only rarely that they approach anything at all like the classical idea of an apical initial. They are not large, well-defined, well-vacuolated cells cutting off segments with a volume considerably smaller than their own. Instead they are usually rich in cytoplasm and divide into almost (? quite) equal parts, and the one which happens to be nearer the tip is destined to continue as the initial merely because of its position. All the cells of quite a large group are totipotent, and their positioning in the apex is probably governed by laws comparable with those which determine the packing patterns of bubbles in the end of a test tube rather than by any qualities inherent in the cells themselves. Moreover, the position taken up by a cell governs its subsequent development.

The view that the exact mode of origin of the inner tissues of the apex is not significant is further confirmed by the constant development behind the apex of the hypodermis and sub-hypodermis, often quite irrespective of details of segmentation at the actual tip, demonstrated especially by apices of the type shown in Fig. *d*. From recent studies it is becoming increasingly evident that the zonation of all apices is to be thought of in terms of levels of relative differences in aeration, nutrition, etc. It is not a morphological but a metabolic zonation rather akin to a gardener's 'top-soil' and 'sub-soil'. The nearer a cell is to the surface, the more it tends to divide exclusively by anticlinal walls, an effect which bears absolutely no relationship to the number or positioning of the 'initial' cells, and which leads to the production a little way back from the extreme tip of clearly distinguishable layers, the numbers of which will tend to be greater the more massive the apex. In grass apices of the long type this zonation will be very noticeable; but it will be masked in short apices by the divisions connected with the onset of leaf and bud initiation. The metabolic view also makes the observed occasional periclinal divisions unconnected with leaf initiation in the dermatogen itself to be expected, especially in very young axillary buds or the plumules of young seedlings.

Since the exact origin and fate of the various layers are so flexible in the grass apex, Hanstein's terminology cannot be used in its strict sense, nor is the *tunica-corpus* terminology in Buder's[5] (but not in Schmidt's[6] and Foster's[7]) sense very useful. However, using these and Koch's[8] similar terminology (originally suggested for Gymnosperms) purely as descriptive of the tissue zonation of the apex without any implications as to derivation or destiny, the equivalents are as follows:

Tissue	Hanstein	Koch	*Tunica-corpus*
Outer layer	Dermatogen	Mantle (Hullgewebe)	Tunica
Hypodermis	Outer periblem	Mantle	Tunica
Sub-hypodermis	Inner periblem	Mantle	Corpus (? or transition layer)
Inner core cells	Plerome	Central tissue	Corpus

The construction of the apex has considerable interest for the plant-breeder who wishes to obtain viable gametes by doubling the chromosome complement with colchicine, etc. This is obviously best achieved by affecting the tissues eventually traceable to the hypodermis of the flower-bud primordia. He need not consider whether the main axis has a single initial or a group of initials for both the hypodermis and the inner tissues, and whether or not periclinal divisions occur in the apical cells of the hypodermis of axillary buds. He must merely realize that the earlier he treats his seedling the better because: (1) in young seedlings the whole of the hypodermis is being derived from fewer initials, so that should he have the good fortune to produce a doubling in an initial, it will produce a wide sector of cells with the new constitution, and it may also be the parent of some of the other initials when the group increases in number; (2) even if he succeeds in only doubling the complement of a hypodermal cell on the flank of the apex, if effected early this will be represented in all the tiller buds from that sector, whereas successively later local doubling in the hypodermis will only affect blocks of primary, secondary and then tertiary, etc., inflorescence buds (in the case of a paniculate inflorescence), or spikelet buds and later only floret initials.

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[2] Rösler, P., *Beit. Biol. Pflanzen*, **5**, 28 (1928).
[3] Porterfield, W. M., *Peking Soc. Nat. Hist. Bull.*, **4** (3), 7 (1930).
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[5] Buder, J., *Ber. Bot. Ges.*, **43**, 20 (1928).
[6] Schmidt, A., *Bot. Arch.*, **8**, 345 (1924).
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EXPERIMENTAL MORPHOLOGY OF PTERIDOPHYTES

PHYSIOLOGICAL and experimental observations have hitherto played virtually no part in helping to elucidate problems connected with the organization of the plant body in Pteridophytes. The approach towards these problems has been almost exclusively morphological in inception and outlook. Some experimental investigations recently recorded by Prof. C. W. Wardlaw (*Ann. Bot.*, New Series, **7**, Nos. 26 and 28, 8, Nos. 30/31 and 32, April and Oct. 1943 and April–July and Oct. 1944) dealing with bud development and stelar morphology in ferns have yielded results of great interest and significance which indicate the value and potentialities of this previously neglected approach to morphological problems.

It has long been held that one of the morphological characteristics distinguishing ferns from seed

plants is the inconstancy in the positional relationship of buds to shoot and leaf in the former group. Though sometimes they occupy definite axillary positions, they commonly arise in extra-axillary positions which apparently show no fixed relationship to the foliar organs. Prof. Wardlaw's observations, however, suggest that, though the final position of the bud is so variable, its point of initiation does in fact show a definite relation to the foliar organs, and the ultimate position it comes to occupy is explicable in terms of relative growth activities.

Investigations on *Matteuccia struthiopteris* and *Onoclea sensibilis* have shown that, on the normally unbranched rhizomes of these dictyostelic species, buds may be induced by removal of the terminal meristem. These buds are initiated in superficial areas of meristematic cells which, in the normal rhizome, remain quiescent. The origin of the patches of meristematic cells can be traced to the apical meristem, from which they become detached and persist on the surface of the shoot in definite positions corresponding to the point of union of the merist les at the distal end of the leaf gap, that is, in the axis of a leaf but some distance above its insertion.

In *Dryopteris Filix-mas*, defoliation experiments involving the removal of fronds and destruction by puncturing with a needle of the smallest visible leaf primordia proved effective in bud formation. The buds were situated either on the leaf-base near its point of confluence with the shoot or some distance along the petiole. Investigation showed that the buds always arise on the shoot in an approximately axillary position, despite the abaxial position at some distance above the petiole base which they eventually may come to occupy. Their origin was traced to the activity of epidermal cells lying in close proximity to points of meristele conjunction in the vascular meshwork of the shoot and therefore comparable in position with those of the other species investigated.

The position which the bud ultimately comes to occupy on the petiole is due to the very great transverse growth expansion of the basal region of a developing leaf primordium. This causes displacement of the much more slowly growing bud from its original axillary position, and leads to its being carried up on the enlarging base of a developing frond. The enlarging frond base on which the bud is thus caught up may lie in a longitudinal or a lateral position with respect to the bud, so that the bud may become separated in space from the leaf to which it originally stood in an axillary relationship.

Further observations along these lines may well reveal that the point of origin of buds is fundamentally the same in all ferns, and that the varied positions which they eventually occupy may be wholly explicable in terms of specific growth distribution in shoot and leaf.

In the field of stelar morphology, chief consideration has always been devoted to fully differentiated tissue systems ; and though a fairly complete picture has been obtained of the progressive increase in complexity of the stele during ontogeny, little attention has been paid to the development of the shoot as a whole from the apex backwards. Hence developmental studies in the stelar morphology of ferns, comparable in detail with the ontogenetic studies of their reproductive structures or with the dynamic aspect of tissue differentiation behind the growing point in the Angiosperms, are not available.

Prof. Wardlaw recognizes two phases in the development of vascular tissues, namely, the "initial differentiation", whereby vascular tissue can be distinguished from cortical tissue, and the "subsequent differentiation" characterized by the specialized development of the constituent vascular elements. It is in the region situated immediately below the apical meristem that the "initial differentiation" takes place, and it is suggested as a working hypothesis that this initial differentiation of vascular tissue is inseparably connected with the immediate proximity of an apical meristem in a state of active growth, its position and behaviour being causally related to one or more unspecified substances diffusing from the meristematic cells.

Evidence adduced for the Pteridophytes in general is fully in accord with the fact that wherever an actively growing apex is present, vascular tissue may be observed in the process of differentiation immediately behind it. Moreover, that the maintenance of the actively meristematic condition is all-important is indicated by the disappearance of the zone of initial differentiation behind dormant apices. It is shown that the discontinuous vascular strands which have been described by Holloway in large prothalli of *Psilotum triquetrum* are associated with discontinuous apical activity, while instances cited of vascular tissue differentiation in experimentally induced buds on fern rhizomes, in the protocorms of Lycopods and their attached leaves, and in certain regenerative growth processes which have been described in *Lycopodium Selago*, all clearly point to the fact that where the apical growth is not actively maintained, stelar tissue is not differentiated.

The application of experimental methods to the problem of the relation of leaf development to stelar morphology in ferns has yielded results of outstanding interest. These results throw new light on the factors determining the form of the axial stele and supply an answer to the much-debated question of the cauline versus foliar nature of the stem stele.

It was observed that in *Dryopteris Filix-mas*, immediately below the apical meristem, there is an uninterrupted ring of vascular tissue in the initial stage of differentiation, while in the earliest stages of development of the fronds the vascular supply to the young primordia shows no leaf gaps. These develop a little later, their formation being associated with mechanical stresses resulting from the enlargement of the vascular systems of the leaf bases. Experimental verification of this relationship was sought by defoliating rhizomes and destroying the young leaf primordia by needle puncturing with a micro-manipulator. The apical meristematic cone alone was left intact. The rhizomes were planted in moist peat and new leaf primordia were regularly destroyed as they developed. The suppression of leaf growth was found to lead to the failure of leaf gaps to form, and therefore to the substitution of a solenostele in place of the dictyostele characteristic of this species. When new leaf primordia were allowed to develop again on treated rhizomes, the specimens showed solenostely in the treated region of the shoot, with a return to normal dictyostely in the terminal region. Similar experimentally induced solenosteles were obtained in *Onoclea sensibilis*. The development of a substantial shoot stele in both species in the absence of any associated leaf growth affords proof of the truly cauline nature of the stele.

W. A. SLEDGE.

ORGANIZATION OF RESEARCH IN THE U.S.S.R. INSTITUTE OF PHYSICAL PROBLEMS

ON May 18, 1943, Prof. P. Kapitza presented a very long report at the meeting of the presidium of the U.S.S.R. Academy of Sciences in which he dealt with the organization of scientific work at the Academy of Sciences. An official translation into English of parts of the report has recently been made available in Great Britain in Bulletin, 9–10, 1943, of *VOKS*, the organ of the U.S.S.R. Society for Cultural Relations with Foreign Countries, and has been used in the preparation of the following account*.

On the basis of his experience at Cambridge, Prof. Kapitza felt that the organizational forms of scientific work accepted in the West could not be applied unchanged in the U.S.S.R. "This is principally caused by the fact that in our socialist country science occupies a special place. Of course it is well known and commonly accepted in the other countries too, that science plays a great role in the development of the culture and technology of the country. But in our country science is recognized as one of the essential mainstays of the development of culture and is accorded a leading position in the development of our technology and national economy. For this reason the organization of science in our country must have a more purposeful character than that to be found in other countries, where it is rather accidental and spontaneous. The connection between science and life must be close and more complete."

As Prof. Kapitza's Institute is so young—it is only seven or eight years old—and moreover is devoted to work, on strong magnetic fields and low temperatures, which was but little developed in the U.S.S.R. at the time, the first years were spent in forming and training the scientific personnel and staff. "The question I put before myself from the very outset was what sort of problems must an institute of the Academy of Sciences work up ? . . . I had in mind an institute of physics or . . . an institute devoted to research in the field of natural science. . . . I emphasize further that I am speaking in particular of the organization of an institute of the Academy of Sciences. What is the Academy of Sciences ? It is the Chief Headquarters of Soviet Science. In my opinion it is called upon to direct all our science ideologically, from top to bottom, along a sound channel. Each of its separate institutes must pursue the same policy, that is, aspire to wield a directing influence on science in the field in which it is working, and strive to bring it into the front ranks. For this reason, the first task which an institute of the Academy of Sciences must set itself is to study a great science." In the official translation, 'great' is used throughout, but from the definition given it would appear that the correct translation is 'pure' as distinct from applied science. 'Great' science is "the science that studies the essential phenomena necessary for the most profound knowledge of nature", but it is explained that "the task of a science is to give the necessary knowledge for transforming nature so that it can serve man in his cultural development". For this reason the choice of the fields of research of an institution is extraordinarily important, and Prof. Kapitza would choose the fields of low temperatures, the atomic nucleus and the solid state as the most important at the present time.

"Only a person with a profound creative talent and one who treats his work creatively can achieve considerable success in 'great science'. For this reason the leading group of the institute must undoubtedly be formed from a few carefully picked workers who must devote themselves wholeheartedly to scientific work with not more than twenty per cent of their time given up to social or other non-scientific activities." From the emphasis laid upon conditions that the worker must be able to stay in the laboratory and himself work there, it is clear that Prof. Kapitza would not approve of what might be called 'office' research in which meetings and memoranda continually interrupt actual research work. "Only when one works in the laboratory oneself, with one's own hands, conducting experiments even the most routine parts of them,—only under these conditions can real results be achieved in science. Good work cannot be done with other people's hands. . . . I am certain, that the very moment even the greatest scientist stops working in the laboratory himself, he not only ceases to develop but, in general, ceases to be a scientist. These principles are very important, but they belong only to peace-time ; war-time forces us to act differently."

The greatest emphasis is laid upon these principles, particularly with beginners. "For this purpose I try to put their work into rather rigid organizational frames. For instance, a scientific worker must not be occupied with several subjects at one time, especially if he is at the beginning of his scientific career. When the scientific worker has grown somewhat and become more experienced, he may be able to work simultaneously on two or three subjects as a rare exception ; but he must always begin with one."

Attention is then directed to the dangers of overwork. "The next point in the organization to ensure successful work, is that the scientist must work in the laboratory a limited number of hours. Long spells of work are harmful ; it is exhausting and lowers a person's creative powers." The regime observed by the workers in the Institute for Physical Problems at Moscow is that usually all laboratory work stops at 6 p.m., after which the worker leaves for home "to ponder on his work, read, study and rest". Exceptionally, by permission of the vice-director, work may continue until 8 p.m. Night work is sanctioned only by the director when it is justified by technical necessities of the experiment.

The next problems discussed are how such an Institute can influence the development of the science of the country and can avoid becoming a closed and isolated unit, which latter would be contrary to one of the principles laid down earlier. Several means are discussed. First of all, full advantage must be taken of the privileges of an institute of the Academy of Sciences, whereby the Institute has access to "rich and modern technical equipment" and to a wide field in selecting experienced staff. The special plant for making liquid helium in quantity gives the Institute for Physical Problems exceptional possibilities for doing experiments at very low temperatures. Next, these facilities are made available to workers in other institutes. Such visits are usually arranged as follows. "The comrade who wishes to work at our institute is invited to our scientific meeting where he reports on

* A complete translation of the speech together with that of a long discussion has been made by the Science Section of the Society for Cultural Relations with the U.S.S.R., 98 Gower Street, London, W.C.1.

the experiment he proposes to conduct. This is discussed and, if the proposal is of scientifically grounded interest and the author is sufficiently qualified, he is given the opportunity to do his work." Not more than two or three outside workers can be accommodated at the same time without disorganizing the main work of the Institute. So far there have been more suitable applications than could be accommodated.

These guests form a vital link with other institutes, for not only is a knowledge of the work of the Institute for Physical Problems spread by them but also the guests keep the Institute informed of what is being done elsewhere. Prof. Kapitza is no believer in isolation, as the following passage shows. "In the future similar vital contacts must be established with scientists in other countries. Scientific workers from abroad visited us during the first years of the existence of our Institute. But in recent years the political situation has grown so complicated, that though there were those who wanted to come here, our connections with foreign countries had been severed, so we can only speak of this aspect of our relations with foreign scientists in view of plans for the future. But these relations must, of course, be deemed a normal and sound condition of the work of any academic institute, because science throughout the world comprises one indivisible whole."

Another function of the Institute is to train scientific workers. Prof. Kapitza was not satisfied with the external method of selecting postgraduate students. "Only the institute itself can train its future personnel, and it must do so with great diligence, by gradually nurturing them from youth." The method of selection used for two or three years before the War gave unique opportunities to students at the University of Moscow. "Taking advantage of the fact that we possess greater amounts of liquid helium for experiments at low temperatures than the refrigerating laboratories of the whole world put together, we were in a position to set up a practicum at the institute, which is attended by every student of the Moscow University School of Physics." At first, only the best students were admitted; but later every student was allowed to do two or three experiments, using liquid helium for the study of such phenomena as supraconductivity and magnetic properties near 0° A. The best of the students, if they wished, were allowed to do more than the three experiments, and from the beginning of their third or fourth university year were in close contact with the Institute. Later they were invited to help with the research work as junior laboratory assistants. Prof. Kapitza thinks that if the scheme had not been interrupted by war, probably one out of ten or fifteen of these students, on completing their graduate work, would have proved sufficiently talented to remain on the main scientific staff of the Institute.

"This method of observing young students from the time they are at the university, the thorough and constant verification of their abilities is, in my opinion, the only correct way of selecting young scientific workers, so far. . . . As you grow older, it is only young people, only your pupils, who can save you from premature mental staleness. Of course, every pupil must know more about the field in which he is working than his teacher. And who teaches the teacher, but his pupils? Thanks to his experience the teacher supervises the general fund of the work, but he is taught by his pupils, who deepen his knowledge and extend his scope." The difficulty of making correct statements about the human being doing creative work is illustrated by Kapitza's statement that "without pupils the scientist very soon dies as a creative unit and ceases to advance". Faraday had no pupils. Rutherford told Kapitza that "it is only because of my pupils that I, too, feel so young". Prof. Kapitza ends the first section of his address with the words "as I myself am approaching old age, I feel that intercourse with youth must be the modus vivendi, safeguarding one from withering away and insuring the maintenance of courage and interest in all that is new and advanced in science. Conservatism in science is worse than premature death to a scientist; it acts as a brake on the development of science."

W. H. GEORGE.

OBITUARIES

Dr. G. D. Bengough, F.R.S.

DR. GUY DUNSTAN BENGOUGH, whose name is particularly associated with research on the corrosion of metals, died in the East Sussex Hospital, St. Leonards, on January 20. He was born in 1876, the son of Major E. B. Bengough, and was educated at Malvern and at Selwyn College, Cambridge. He then studied metallurgy at the Royal School of Mines and worked for a short time at the Royal Mint, gaining experience in research under Sir William Roberts-Austen. He went to Burma for practical experience in the extraction of gold and tin ores, and then held teaching posts in the Universities of Birmingham and Liverpool.

While at Liverpool, Bengough published papers on the rupture of metals at high temperatures, in which he showed that the normal fracture through the crystals of a metal gave place to one passing between the crystal grains when a certain critical temperature was exceeded. This he attributed to the presence between the grains of a non-crystalline layer, having some of the properties of a glass, being rigid at low and viscous at high temperatures. The same idea was suggested independently by Dr. Rosenhain, and this conception of an 'amorphous intercrystalline cement', although questioned by some, became popular, and long served as a basis for research.

It was while at Liverpool that Bengough began work on the corrosion of metals, especially brass marine condenser tubes, for the Institute of Metals. A series of reports was issued, in which the conditions determining general corrosion and pitting were examined, and new experimental methods were devised. The work was interrupted by the War of 1914–18. Bengough obtained a commission in the Royal Artillery, and in 1916 was captain and adjutant. He was, however, seconded for work for the Admiralty and later for the Royal Flying Corps, and continued work on corrosion in the Royal School of Mines. He later became a principal scientific officer in the Chemical Research Laboratory at Teddington, and from then onwards devoted himself to the investigation of corrosion, giving special attention to the design of apparatus.

In 1926 Bengough devised the method of anodic protection of aluminium and its alloys which proved of very great industrial value. Not only did the film produced by his method give a high degree of resistance to corrosion, but also it could be given a definite degree of porosity, so that the surface could be made to take dyes or pigments, opening up a wide field of

decorative work. He was also responsible for a method of protecting magnesium and its alloys by depositing selenium, which, however, had certain practical disadvantages.

Much of Bengough's later work was done for the Joint Corrosion Committee of the Iron and Steel Industrial Research Council and the Iron and Steel Institute, and after retiring from Teddington in 1936, he continued to act as consultant to that body and to the Department of Scientific and Industrial Research, being chairman of the Marine Corrosion Sub-Committee.

Bengough's work was marked by a high standard of accuracy. He devised methods by which extraneous factors were so far as possible excluded, so that the results were reproducible. By using carefully designed apparatus, he determined the course of the corrosion process by measuring the absorption of oxygen and when necessary the evolution of hydrogen, so that characteristic corrosion-time curves could be drawn. Such carefully selected conditions cannot, of course, reproduce those of attack on a ship's plate or a condenser tube, and the relations between laboratory results and practical experience have been the subject of much controversy. Bengough laid most stress on the properties of the products of corrosion in determining its subsequent course, whereas Dr. U. R. Evans and his collaborators attached chief importance to the principle of differential aeration. The two investigators were approaching the problem from different angles, and their views were less irreconcilable than they had seemed at first, so that in 1938 a joint statement was issued which showed how great was the measure of agreement. A series of six papers by Bengough and his colleagues in the *Proceedings of the Royal Society*, of which he was elected a fellow in 1938, contains an account of a long series of quantitative experiments on corrosion. Other laboratory work is described in the reports of the Corrosion Committee published by the Iron and Steel Institute, and here his chief service was that of laying down the conditions which must be observed in making standard tests of corrodibility.

Tall and military in appearance and seemingly robust, Bengough had long periods of serious illness before that which led to his death. He was a good chairman and always showed good temper and courtesy in dealing with a notoriously controversial subject.

Dr. Bengough married Constance Helen, daughter of Lieut.-Colonel Jelf-Sharp, who survives him.

C. H. DESCH.

Prof. V. I. Vernadsky

PROF. VLADIMIR IVANOVICH VERNADSKY, one of the leading mineralogists and geochemists in the U.S.S.R., died on January 6. He was born at St. Petersburg on March 12 (February 28, Old Style), 1863. After graduating at the University of St. Petersburg in 1886, he spent some time in Paris working in the laboratories of Le Chatelier and Curie, and in 1896 was appointed professor of mineralogy at the University of Moscow. In 1906 he was elected a member of the Russian Academy of Sciences.

Prof. Vernadsky's early work was devoted to a chemical study of alumino-silicates, a subject which he later expanded and applied in a wider field of the structure of silicates and especially of kaolinite, feldspars and chlorites. At the same time he was working on descriptive mineralogy and he described and named a number of new minerals. In his lectures at the University he began to break new ground by stressing the genetic aspect in mineralogy. This genetic approach to mineralogy was fully developed in his books: "Essay on Descriptive Mineralogy" (1908, 1910) and "History of Minerals of the Earth's Crust" (1925, 1933). Eventually genetic mineralogy overstepped its proper boundaries and became merged in the far wider field of geochemistry. Thus Vernadsky may be considered the founder of the new Russian school of geochemistry, which has made such gigantic strides during the last three decades.

The greater part of Vernadsky's work on geochemistry appeared in the form of numerous papers, but a good presentation of it may be found in his book "La geochimie", published in French in 1924. It is a most stimulating book, full of daring ideas and wide generalizations. But even more daring is his book "La biosphere", published in 1929, in which he made an attempt to incorporate biological processes into his general scheme of geochemistry.

Endowed with a versatile genius and full of tremendous energy and enthusiasm, Vernadsky spread his activities far and wide. He organized regular research in mineralogy and geochemistry, helped to establish the Mineralogical Museum in Moscow, promoted the establishment of numerous scientific institutions—such as the Biogeochemical Laboratory, the Radium Institute, a permanent committee for the study of meteorites, and others. He was also the founder and the first president of the Ukrainian Academy of Sciences. Vernadsky was well known outside the U.S.S.R. Since 1920 he spent some years in Paris and Prague working and lecturing. He was a member of the Paris Academy of Sciences and the Czechoslovak Academy. He visited Great Britain in 1923, when he took part in the meeting of the British Association in Liverpool.

Vernadsky's direct contributions to science are considerable, but they are dwarfed by the greater importance of his influence on the development of new ideas in geochemistry and mineralogy. As a teacher he was most stimulating. He could easily divert the wealth of his erudition into fresh channels and mark out new lines of research. He was greatly admired and loved by his pupils and colleagues, even by those who violently opposed his views.

A bibliography of Vernadsky's works up to 1936 was given in the 'Vernadsky Jubilee Volume' published by the Academy of Sciences of the U.S.S.R., two articles in *Bull. Acad. Sci. URSS.*, Géol. Sér., No. 1 (1944), one by D. P. Grigoryev (p. 25) and the other by V. G. Kryzhanovsky (p. 35) give an account of his work, and a short account of the development of geochemistry in the U.S.S.R. has appeared in *Nature* (154, 814; 1944).

S. I. TOMKEIEFF.

WE regret to announce the following deaths:

LORD DAWSON OF PENN, P.C., G.C.V.O., K.C.B., president during 1931–38 of the Royal College of Physicians, on March 7, aged seventy-nine.

Prof. F. W. Eurich, emeritus professor of forensic medicine in the University of Leeds, known for his work on anthrax, on February 16, aged seventy-seven.

Sir Duncan Wilson, C.V.O., C.B.E., until 1940 chief inspector of factories (Home Office), and secretary during 1918–30 of the Industrial Health Research Board, on March 1, aged sixty-nine.

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

COMMONWEALTH OF AUSTRALIA

COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH—DIVISION OF INDUSTRIAL CHEMISTRY

Appointment of Officer for Ceramics Research

Applications are invited for appointment to the position of Research Officer on the staff of the Council's Division of Industrial Chemistry, Melbourne, for research work in ceramics.

An applicant should have a University Degree in Science, or equivalent qualifications, and have special training in mineralogy, inorganic chemistry or physical chemistry, with research experience, preferably in ceramics. The appointee, depending on his training and experience, may be expected either to proceed to Australia to survey local raw materials and products, and later return overseas to undertake special studies on ceramics, or to undertake special studies before proceeding to Australia.

The salary will be in the range £A560 to £A640 (actual), depending on the qualifications and experience of the successful applicant.

Subject to a satisfactory medical examination, the successful applicant will be appointed initially on probation for a period of twelve months, and thereafter, if confirmed in the appointment as an officer of the Council, will be eligible to contribute to, and receive benefits from, either the Commonwealth Superannuation Fund or the Commonwealth Provident Fund.

Applications, stating age and nationality and giving particulars of qualifications and experience and of present employment and accompanied by copies of not more than four testimonials, should reach the Secretary, Australian Scientific Research Liaison Office, Australia House, Strand, London, W.C.2, not later than April 2, 1945.

(Signed) G. A. COOK,
Secretary.

Council for Scientific and Industrial Research,
314 Albert Street,
East Melbourne, C.2.

VETERINARY EDUCATIONAL TRUST

ELECTION OF TWO COOPER CENTENARY FELLOWSHIPS

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

The Fellowships, to the value of £450 per annum (liable to Income Tax), are tenable for one year and for a subsequent period of two years at the discretion of the Advisory Committee. The Elections will normally take effect as from September 1, 1945, but an earlier date may be agreed in special circumstances. Applications must be received before March 26, 1945.

Forms of application are obtainable from: The Honorary Secretary, Cooper Centenary Fellowships for Veterinary Research, 40 Westminster Palace Gardens, Westminster, London, S.W.1.

APPLICATIONS ARE INVITED FOR THE FOLLOWING APPOINTMENTS

1. Research Physical Chemist.
Research Organic Chemist.
Research Bacteriologist.

Salary from £500 p.a. upwards according to ability and experience.

2. Intelligence Officer and Librarian (woman B.Sc.). Salary from £300 upwards.

3. Required to take charge of Dairy Control Laboratory: Experienced worker, preferably with B.Sc. or N.D.D. Good graded salary. Permanent for suitable person.

4. Required for training as workers in Dairy Control Laboratories: Girls aged 16-18 years with at least School Certificate, but preferably with Matric. or Inter B.Sc. Special facilities given for training and for taking diploma or degree courses if applicant suitable.

Send full details of qualifications and experience to the Secretary, Express Dairy Company Ltd., Tavistock Place, W.C.1.

(Public Notices)

UNIVERSITY OF EDINBURGH

FELLOWSHIPS FOR SCIENTIFIC RESEARCH

Established by Imperial Chemical Industries Ltd.

The University is about to consider the election of a limited number of experienced Research Fellows in Physics and Chemistry, including Physical and Organic Chemistry, Biochemistry, Chemotherapy and Pharmacology.

The appointments will date from Oct. 1, 1945, or such later date as may be arranged in the case of successful candidates who are at present engaged in National work.

Stipends will be in the region of £600 per annum and appointments will normally be for three years.

Full particulars and forms of application may be obtained from the undersigned with whom applications must be lodged not later than April 30, 1945.

W. A. FLEMING,
Secretary to the University.

UNIVERSITY OF GLASGOW

Applications are invited from experienced research workers for I.C.I. Research Fellowships in Chemistry, Engineering, Pharmacology and Physics, to which some appointments may be made during the current academic year. The appointments will date from Oct. 1, 1945, or such later date as may be arranged in the case of successful candidates who are at present engaged in National Service. The stipends will be in the region of £600 per annum, and appointment will be for three years in the first instance. Applications, with list of publications and names of two referees, should be sent not later than April 30 to the undersigned, from whom further particulars may be obtained.

ROBT. T. HUTCHESON,
Secretary of University Court.

UNIVERSITY OF GLASGOW

Lectureship in Genetics

Applications are invited for the Lectureship in Genetics in the University. The Lectureship will be Grade IIa, the salary range of which is £540-£610 per annum. Applications, with the names of three persons, to whom reference may be made, should be sent to the undersigned, from whom further particulars of the appointment may be obtained. The latest date for receiving applications will be April 7, 1945. The appointment will take effect from October 1, 1945.

ROBT. T. HUTCHESON,
Secretary of University Court.

CITY OF CARDIFF EDUCATION COMMITTEE

THE TECHNICAL COLLEGE

Principal: J. Stephenson, M.A., M.Com., D.Sc.

Applications are invited for the post of full-time Lecturer in Biology, to commence duties as soon as possible. Preference will be given to candidates who are well qualified in Botany and Zoology.

The salary will be in accordance with the Burnham Technical Scale.

Forms of application, together with further particulars, are obtainable from the undersigned, to whom they must be returned by March 28, 1945.

W. J. WILLIAMS,
Director of Education.

City Hall,
Cardiff.

UNIVERSITY COLLEGE OF SOUTH WALES AND MONMOUTHSHIRE

The Council of the College invites applications for the following posts in the Department of Physics, viz:

(i) Assistant Lecturer and Demonstrator at a commencing salary of £350 per annum.

(ii) Lecturer, at a minimum commencing salary of £475 per annum.

Further particulars may be obtained from the undersigned, by whom three copies of applications and testimonials should be received on or before April 30, 1945.

LOUIS S. THOMAS,
Registrar.

University College,
Cathays Park, Cardiff.

BIRKBECK COLLEGE

(University of London)

AUTUMN TERM BEGINS ON MONDAY, SEPTEMBER 24

Applications for admission from men and women who desire to read as part-time Internal Students of the University for degrees in the Faculties of Arts and Science, or for the Diplomas in Geography and Psychology, should be addressed to:

THE CLERK,
Birkbeck College, E.C.4.

THE UNIVERSITY OF LIVERPOOL

I.C.I. RESEARCH FELLOWSHIPS

The University invites applications for not more than three "Imperial Chemical Industries Limited" Research Fellowships in Chemistry or Physics or some allied subject such as Biochemistry, Colloid Science, Chemotherapy, Pharmacology, Metallurgy or Engineering. Value about £600 per annum according to qualifications. Permission to defer the beginning of the tenure can be granted to persons engaged upon national service. Particulars as to tenure and conditions and method of application can be obtained from the Registrar, by whom applications must be received not later than April 30, 1945.

STANLEY DUMBELL,
Registrar.

UNIVERSITY OF OXFORD

SEDLEIAN PROFESSORSHIP OF NATURAL PHILOSOPHY

Applications are invited for the above Professorship, and should reach the Registrar of the University by June 2, 1945. Stipend, £1,200 per annum, but Professorship will be included in any reconsideration of stipends. Residence required during six months in each academic year. Retiring age, 65. The selected candidate will not necessarily be required to take up duties at once.

NORTHERN POLYTECHNIC

HOLLOWAY ROAD, N.7.

The Governing Body invite immediate applications for appointment as full-time teacher of Physics and Mathematics. University Degree and teaching experience to Intermediate Science standard essential. Burnham Scale salary.

Forms of application, together with full particulars, will be forwarded on receipt of a stamped, addressed foolscap envelope.

R. H. CURRELL,
Clerk.

THE UNIVERSITY OF LEEDS

REGISTRAR

Applications are invited for the post of Registrar. The appointment will be made by the University Council at a salary within the range £1,000 to £1,200 per annum, according to qualifications and experience.

Further information may be obtained from The Bursar (Acting Registrar), The University, Leeds, 2, to whom applications should be sent not later than April 30 next.

GIRTON COLLEGE, CAMBRIDGE

Applications are invited from qualified and experienced women gardeners for the post of Garden Steward, with responsibility for the upkeep of about 50 acres of gardens and grounds, including large-scale growing of vegetables. Academic qualifications an asset. Particulars may be obtained from the Secretary, to whom applications for the post should be sent before April 10, 1945.

Applications for employment as Technical Assistants are invited from Pass Degree Graduates (either men or women) in physics, maths, or mechanical engineering, or from Graduates with a general degree in such subjects, under 25 years of age, for analysis and reporting of aircraft vibration development and research tests. Salary not less than £4 10s. per week at 21 for either sex, plus Federation Scale of war bonus. Experience not necessary. No appointments will be made until all relevant restrictions covering such engagements are withdrawn, except in the case of women not covered by the Employment of Women (Control of Engagement) Orders, 1942-3.—Reply, Box 322, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Metallurgist required to be in charge of Laboratory, Test House, and Hardening Processes at large Aircraft Works in Midlands. Must be conversant with heat treatment of light alloys and aircraft steels, as used in Aircraft Industry. Good qualifications and experience required. The man appointed will work directly for the Works Manager. Salary £500 per annum, plus bonus, upwards.—Applicants should write, quoting F.3732XA, to the Ministry of Labour and National Service, Appointments Dept., Central (T. & S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2, for the necessary forms, which should be returned completed on or before March 20, 1945.

Wanted: Senior Research Officer for new overseas organization investigating the field of the industrial diamond. Preferably Ph.D. with industrial research experience, capable of investigating the Chemical, Physical, and other properties of industrial diamonds. A knowledge of Metallurgy or Powder Metallurgy would be an asset.—Submit application, complete with details of training and experience with references, to Box 325, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Large Engineering concern in S. E. England requires qualified Metallurgist, age 20-35, of degree standard. Knowledge of non-ferrous metals essential, and knowledge of ferrous metals desirable. Permanent appointment with good prospects. Basic salary £350 to £500 per annum, according to qualifications.

Applicants should write quoting F8537XA to the Ministry of Labour and National Service, Appointments Dept., Central (T. & S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2, for the necessary forms which should be returned completed on or before March 21, 1945.

Applications are invited for the post of General Secretary to the Association of Scientific Workers. Preference will be given to qualified scientist (including engineer, economist, or social scientist). Starting salary £450 upwards, according to experience and qualifications.—Applications to: Hon. General Secretary, Association of Scientific Workers, 73 High Holborn, London, W.C.1.

The Mond Nickel Co., Ltd., invites applications for post of Senior Assistant (either sex) in Technical Information Section of Research and Development Department. Experience in Metallurgy (preferable), Chemistry or Physics essential. Good French and German also required. Abstracting experience desirable.—Apply, stating experience, qualifications, age, salary required, and date available, to the Mond Nickel Co., Ltd., Grosvenor House, Park Lane, London, W.1. Mark envelope "A.T. Confidential."

The British Welding Research Association, 2 Buckingham Palace Gardens, Buckingham Palace Rd., London, S.W.1, require two metallurgists to undertake research in the welding of light alloys. The salary to commence, according to qualifications and experience, £400-£800 p.a.

Imperial Chemical Industries Ltd. have vacancies for an experimental zoologist and for a marine biologist. Details of these posts may be had on application, in writing, to Central Staff Department, Welwyn Garden City, Herts.

Plant Breeding Assistant required, man or woman. Preferably with experience in Fruit and Cytology. Good salary and prospects. Reserved occupation. Box 311, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Physicist required for the Research Staff of an expanding laboratory in a large glass works near Birmingham. Degree in Physics or Mathematics. Salary according to age and qualifications.—Chance Brothers, Smethwick.

Sales Manager with practical experience in Medical and Industrial X-Ray Photography. Write in first instance giving full particulars of past experience, age, etc., to Box 319, T. G. Scott & Son, Ltd., Talbot House, 9 Arundel Street, London, W.C.2.

Technician required for Radon Centre in the country; scientific qualifications not essential.—Apply, Barnato Joel Laboratories, Middlesex Hospital, London.

Wanted: A Laboratory Technician with some acquaintance with bacteriology and with the care and handling of experimental animals. Salary up to £200 a year, with war bonus.—Apply, Secretary, National Institute for Research in Dairying, Shinfield, Berks.

Required by manufacturers of anti-fouling compositions, graduate (physical chemistry) with research experience. Salary £450/£550 per annum.—Apply, Box 324, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Chemist required, knowledge of dairy chemistry. State experience, age, salary required and when free.—Box P.100, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Wanted to purchase first-class Micro-scope for urgent National Work. Excellent price. Box 314, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Required urgently, Heavy Microtome suitable for cutting sections of hardwoods about 20 microns thick. Box No. 321, T. G. Scott & Son, Ltd., Talbot House, 9 Arundel Street, London, W.C.2.

Wanted: Complete sets and runs of Scientific Periodicals, including NATURE and Learned Society publications.—The Scientific Book Supply Service, 5 Fetter Lane, London, E.C.4.

Polyglot Translation Service Ltd., 287 Terminal House, London, S.W.1. Telephone: SLOane 7059. Translations of every description from and into all languages.

Microscopes, of all descriptions, only a few available, second-hand, perfect condition. Send details of your requirements, enclosing 3d. stamp.—Telephone or correspondence only, Chards, Forest Hill, S.E.23 (Spring Park 1628).

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NEWS and VIEWS

Royal Scottish Museum, Edinburgh: Mr. Thomas Rowatt, O.B.E.

On reaching the age limit, Mr. Thomas Rowatt has recently retired from the directorship of the Royal Scottish Museum, which he has held since 1934. He entered the Civil Service as assistant in the Technological Department of the Royal Scottish Museum in 1902, became assistant-keeper in 1909 and keeper of the Department in 1921. The period of his directorship marked steady progress in the development of the activities of the Museum, and although the building was closed to the public on the outbreak of the War, and its valuable collections were dispersed to places of safety, Mr. Rowatt has in recent years arranged for special exhibits which have proved attractive to the people of Edinburgh and to the city's many visitors from overseas. Perhaps the most popular of these has been the present Fisheries Exhibition, arranged in co-operation with the Fisheries Department of the Scottish Home Office, at which the comprehensive collection of exhibits illustrating many aspects of Scottish fisheries has been supplemented by weekly lectures on a wide variety of fishery topics by recognized experts.

Dr. Douglas A. Allan

Mr. Rowatt has been succeeded in the directorship by Dr. Douglas A. Allan, formerly director of the Liverpool Public Museums. Dr. Allan is a graduate of the University of Edinburgh, where he specialized in geology, taking part in the late Dr. W. S. Bruce's expeditions to Spitsbergen, and acting as assistant in the University Department of Geology under the late Prof. T. J. Jehu. During 1925–29 he was lecturer in geology in Armstrong College, University of Durham, and in the latter year was appointed director of the Liverpool Museums. Dr. Allan has taken an active part in the promotion of museum interests as chairman of the Museums Association and as a member of the Post-War Reconstruction Committee on Museums and Art Galleries. Last year he was awarded the Neill Gold Medal of the Royal Society of Edinburgh for his researches on the geology of the Highland border in Angus and Perthshire.

Biologist to North of Scotland Hydro-Electric Board

An appointment of more than usual interest to naturalists has been announced by the North of Scotland Hydro-Electric Board, the authority for the development of water-power schemes over a considerable area of the most attractive scenery in Scotland. In 1943 the Board appointed Mr. W. L. Calderwood, formerly inspector of Scottish salmon fisheries, as its principal consulting adviser on fishery matters, and he will continue in that capacity; but a full-time fishery adviser and biologist, Dr. John Berry, has now been appointed to ensure that in the planning of new schemes due attention will be given to all aspects which affect wild life. Dr. Berry's wide interests in natural history fit him well for such a post. For some time he was director of the Freshwater Fisheries Research Station at University College, Southampton, and before the War he carried out salmon research for the Fishery Board for Scotland and the Moray Firth Salmon Fishery Company. In 1939 he published for the International Wildfowl Inquiry an exhaustive volume on "The Status and Distribution of Wild Geese and Wild Duck in Scotland". During the War he has been officer-in-charge of Press censorship in Scotland, but naturalists will welcome his return to his proper vocation.

Royal Society of Edinburgh

Awards

The Council of the Royal Society of Edinburgh has awarded the Gunning Victoria Jubilee Prize, for the period 1940–44, to Prof. H. W. Turnbull, University of St. Andrews, for his distinguished contributions to mathematical science and the history of mathematics; and the Makdougall-Brisbane Prize, for the period 1942–44, jointly to Prof. Max Born and Dr. H. W. Peng, University of Edinburgh, for their papers on "Quantum Mechanics of Fields" published in the *Proceedings* of the Society within the period of the award.

New Fellows

The following have been elected ordinary fellows of the Royal Society of Edinburgh: Dr. Robert Aitken, lecturer in dermatology, University of Edinburgh; Prof. C. H. Browning, professor of bacteriology, University of Glasgow; Mr. A. M. Bryan, mining engineer; Dr. William Burns, agricultural commissioner with the Government of India (retired); Dr. L. B. C. Cunningham, superintendent of the Air Warfare Analysis Section, Ministry of Aircraft Production; Prof. A. Durward, professor of anatomy, University of Leeds; Dr. A. Erdélyi, lecturer in the Department of Mathematics, University of Edinburgh; Dr. A. Ghaffar, lecturer in physiology, Robertson Medical School, Nagpur; Dr. W. Spence Haldane, teacher of chemistry, Dunfermline High School; Mr. E. H. E. Havelock, secretary of the Development Commission; Dr. R. E. Illingworth, lecturer on chemistry, School of Medicine, Royal Colleges; Dr. John Jardine, principal assistant secretary, Scottish Education Department; Dr. D. D. Logan, medical practitioner, Woodside, Lanarkshire; Mr. I. S. Macadam, secretary of the Royal Institute of International Affairs; Dr. D. M. McIntosh, director of education for the County of Fife; Mr. H. P. Morrison, publisher; Prof. J. T. Randall, professor of natural philosophy, University of St. Andrews; Dr. James Stirling, lecturer in plant physiology, University of Liverpool; Mr. Meirion Thomas, reader in plant physiology, King's College, University of Durham; Dr. Robert Walmsley, senior lecturer in anatomy, University of Edinburgh; Prof. S. J. Watson, Department of Agriculture, University of Edinburgh, and principal, Edinburgh and East of Scotland College of Agriculture; Mr. James Wilkie, secretary of the Carnegie United Kingdom Trust; Mr. D. C. Wilson, director of T. and H. Smith, Ltd., Corstorphine; Dr. N. C. Wright, director of the Hannah Dairy Research Institute, Ayr; Prof. C. M. Yonge, regius professor of zoology, University of Glasgow.

New Aeronautical Research Establishment

Sir Stafford Cripps, Minister of Aircraft Production, in reply to a question in Parliament, has stated that it is proposed to build a new research and development centre for both civil and military aircraft construction at Bedford. Many new problems have now to be faced with the approach of supersonic speeds, which will need much special apparatus and

up-to-date wind tunnels. It is intended to make a beginning as soon as possible; but the rate at which the equipment will be provided will naturally depend upon the finance available to meet what will inevitably be a costly project. The transfer of both apparatus and staff from the present Royal Aircraft Establishment at Farnborough will be gradual. Farnborough will eventually be retained for special research and development on armament, instruments and such auxiliary services. It is understood that the new centre will not affect the R.A.F. station at Cardington, but will be an extension of a present American bomber station and the Bedford airport at Thurleigh.

The adoption of this scheme completes plans that have been under discussion for a long time in the aeronautical world, and is perhaps the widest organization of industrial applied science ever attempted in Great Britain. The experimentation relative to the immediate progress in aircraft design and the solving of problems arising upon aircraft in use will be the province of the designing and constructing firms. At the Royal Aircraft Establishment the Air Ministry, as purchasers and users of aircraft for the Fighting Forces and possibly to a certain extent for air transport, will deal with their special problems, many of which must be handled in this way as necessarily they will be secret. The new organization will deal with long-range fundamental research of a general nature, that will add to the knowledge of all who use the science of aeronautics in any way. This should extend the usefulness of the Aeronautical Research Committee, a body which, acting in an advisory capacity, has been largely dependent upon the goodwill and the capacity of the industry, Government establishments, and the universities, for the carrying out of its suggestions. The importance of this is obvious, and it is hoped that its development will be able to proceed at a reasonably rapid rate.

Royal Commission for the Exhibition of 1851

AT the 148th meeting of the Commissioners of the Exhibition of 1851, held on May 6, the Princess Royal was elected president of the Royal Commission in succession to the late Duke of Kent. In his survey of the work of the Board of Management during the period immediately before and after the outbreak of war, Lord Macmillan gave reasons for the partial suspension of the scholarship schemes in 1939, when no fresh awards were made although existing scholarships were continued until their holders were absorbed in the national war effort. So great was the demand for the Commission's experienced research workers and engineering students that by the end of 1940 practically all these men and women had relinquished their awards to take up appointments in the technical branches of the services or in special work for the war industries. Referring to the scientific research awards of the Commission, Lord Macmillan emphasized that the scholarship scheme has produced many of the most eminent men of science in academic, industrial and professional life, including sixty-six fellows of the Royal Society and no less than six Nobel laureates. The Commission's industrial bursary scheme has also been very successful and has helped to place in industry more than six hundred graduates who could not depend on their parents for financial support after their university scholarships came to an end. Sir Robert Robinson described the work of the Science Scholarships Committee. Since 1922, when the earlier scheme was revised, 90 senior students and 149 overseas scholars from the Dominions have been appointed. The value of the material derived from the Dominions has been more than gratifying. Their records as a whole show that they are using the knowledge and experience gained as scholars to very great advantage in the scientific service of the Commonwealth.

Coasts of England and Wales

A SURVEY of the scenic qualities of the coasts of England and Wales has been made by Mr. J. A. Steers at the instance of the Ministry of Town and Country Planning. The results are embodied in a map accompanying a paper in the *Geographical Journal* of July–August 1944. The greater part of the coastal scenery is classified as of good or very good quality, with exceptional quality mainly in parts of Wales and Cornwall. Comparatively little, outside certain industrial areas, has been ruined; but Mr. Steers notes the frequent occurrence of bad scattered development marked by huts and bungalows on parts of the East Anglian coast and elsewhere, including, no doubt, coasts in the south-east, an area for the time excluded from the survey. Only a few stretches of coast-line up to the present are under the National Trust, and it is evident that steps will need to be taken speedily, not only to check undesirable building, but also to ensure access to the coast-line. Nor must the coast-line be considered in any rigid conception: in many parts it is a zone, and not a coast, that must be protected. Mr. Steers argues that the many problems relating to the maintenance of our coast-line from both a scenic and also a physical point of view should be the work of a national organization.

Individual Welfare and Human Progress

THE R.A.F. Penrose Memorial Lecture delivered by the Right Hon. H. B. Butler, British Minister at Washington, has been published (*Proc. Amer. Phil. Soc.*, 88, 151; 1944). Mr. Butler discusses the lessons derived from the work of the International Labour Organisation during the last twenty-five years. Its organization, he says, has needed little amendment during its first twenty-five years. It was founded in the belief that the welfare of the common man must be one of the main objectives of human society, the supreme aim of which is individual progress. There can be no peace without social justice; nor can we have social justice without peace. War must go; but economic upheaval must also be prevented. The great slump of 1929–32, which was due, not to inability to produce, but to lack of purchasing power, is likely to recur after the present War, to a more serious degree. That slump taught us that international economic unity is essential. Nations must act together to prevent a repetition of it. Wise planning is not enough. There must be a true conception of life as well. The Fascist danger, spread far and wide, will still be a menace after the War, and it will be one of the tasks of the International Labour Organisation, which has been repudiated by all the Fascist States, to fight it. If we follow purely egoistic and materialistic aims and ignore the good of our neighbours, putting economic above spiritual values, we shall inevitably decline. The cynicism of despair will be equally fatal. But

if we believe that humanity, by its own exertions, can attain a higher and nobler destiny than any it has yet known, then we shall not fail.

Overhead Lines and Outdoor Equipment on A.C. Systems

In a paper read recently in London before the Institution of Electrical Engineers, R. C. Hatton and J. McCombe lay down the guiding principles that for the efficient operation, maintenance and testing of electrical equipment in complex A.C. systems, it is of fundamental importance to provide adequate transport and communication systems, a carefully selected and trained staff at strategic points, and centralized control of all operations, and to enforce the strict observance of a suitable code of safety regulations. The maintenance of the various components of overhead lines and outdoor sub-stations, which the authors' experience has shown to be necessary or desirable, is detailed, and suitable intervals for such maintenance work are indicated. An analysis of faults is made for both the overhead lines and transformers on the system, and the steps are described which have been taken, or which should be taken, for counteracting them. The predominance of faults due to lightning is emphasized and the precautions which can be taken are discussed. Finally, the authors indicate the developments they consider to be desirable to minimize maintenance costs and at the same time to improve the reliability of electricity distribution, with special reference to the system of the Yorkshire Electric Power Co.

Institution of Electrical Engineers: Scholarships for 1945

The Council of the Institution of Electrical Engineers will this year consider the award of three research scholarships and grants, and seven scholarships for undergraduates and students to attend universities and technical colleges. These awards will be made subject to the regulations laid down by the Ministry of Labour and National Service regarding the candidates' ages at the commencement of their courses. *Research Scholarships :* Ferranti Scholarship, £250 per annum for two years; Swan Memorial Scholarship, £120 for one year; War Thanksgiving Education and Research Fund, grants up to £100 for one year. *Student Scholarships* : Duddell Scholarship, £150 per annum for three years; William Beedie Esson Scholarship, £120 per annum for two years, renewable in approved cases for a third year; Silvanus Thompson Scholarship, £100 per annum, plus tuition fees for two years; David Hughes Scholarship, £100 for one year; Salomons Scholarship, £100 for one year; Paul Scholarship, £50 per annum for two years; Thorrowgood Scholarship, £25 per annum for two years. Full particulars can be obtained from the Secretary, Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2. The closing date for receiving applications is April 15, 1945, and the awards will be made towards the end of June.

Conference on X-Ray Diffraction Analysis

The X-ray Analysis Group of the Institute of Physics will hold a conference during April 12 and 13, at the Royal Institution, London, under the chairmanship of Sir Lawrence Bragg. The programme includes a lecture by Prof. J. D. Bernal on "The Future of X-ray Analysis", and a series of papers on new and improved methods. Discussions are to be included on the equipment of a laboratory for X-ray analysis, the interpretation of X-ray diffraction by optical principles, and the proposal to convert X-ray wave-lengths to absolute values. Further particulars may be obtained from the honorary secretary of the Group, Dr. H. Lipson, Crystallographic Laboratory, Free School Lane, Cambridge.

Care of Laboratory Animals

The Universities Federation for Animal Welfare (UFAW), 284 Regent's Park Road, Finchley, London, N.3, has been collecting information for a handbook on the care of laboratory animals. Major C. W. Hume and Dr. F. Jean Vinter state that they still require information about maintaining healthy stocks of the larger species—cats, dogs, the smaller ungulates and primates. These species will not be dealt with in detail in the handbook, but references will be given to published accounts of methods of maintaining healthy and contented stocks and a list provided of laboratories at which advice on the subject can be given at first-hand.

Announcements

The Senatus of the University of Edinburgh has awarded Cameron Prizes for 1945 "for a highly important and valuable addition to Practical Therapeutics" to Sir Alexander Fleming in recognition of his discovery of penicillin, and to Sir Howard Florey in recognition of his work in making possible the clinical application of penicillin.

The title of professor of chemical pathology in the University of London has been conferred on Dr. E. J. King, in respect of the post held by him at the British Postgraduate Medical School.

Prof. Douglas Hay, honorary professor of mining in the University of Sheffield, has been appointed a member of the Board for Mining Examinations in succession to the late Mr. Robert Clive.

The trustees of the Miners' Welfare National Scholarship Scheme, established by the Miners' Welfare Commission for the provision of university scholarships for workers in or about coal mines and their sons and daughters, have appointed Prof. J. F. Duff, vice-chancellor of the University of Durham, to be chairman of the Selection Committee in succession to Sir Franklin Sibly; and Prof. W. E. Curtis, professor of physics at King's College, Newcastle-upon-Tyne, to be a member of the Committee in succession to Prof. A. M. Tyndall.

The Royal Society of South Africa elected the following to fellowship during 1944 : Dr. R. A. Dyer, chief of the Division of Botany and Plant Pathology, Pretoria, well known for work on the Euphorbias; Dr. N. Sapeika, assistant professor of pharmacology, University of Cape Town, and author of "Actions and Uses of Drugs"; and L. H. Wells, lecturer in anatomy, University of the Witwatersrand, and anthropologist.

Erratum. In *Nature* of February 24, p. 233, Prof. Sydney Chapman was wrongly described as "chief professor of mathematics, University of London". Prof. Chapman is chief professor of mathematics in the Imperial College of Science and Technology, University of London.

LETTERS TO THE EDITORS

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

A New Vitamin A

AN earlier publication[1] presented evidence which indicated that fish liver oils contain a substance (or substances) which has vitamin A activity but differs in properties from the vitamin A (here designated A_1) previously obtained in crystalline form[2]. Subsequent research has revealed that the newly recognized compound occurs in fish liver oils in substantial amounts, being responsible for approximately one third of their total vitamin A potency.

We have succeeded in isolating the vitamer* from fish liver oils in pure form. It crystallizes as light yellow needles (m.p. 59–60°) which contrast with the yellow prisms (m.p. 62–64°) of vitamin A_1. It has an absorption maximum at 328 mμ ($E^{1\text{ per cent}}_{1\text{ cm.}} = 1675$) while vitamin A_1 has its absorption maximum at 325 mμ ($E^{1\text{ per cent}}_{1\text{ cm.}} = 1750$). It is an alcohol which forms a red anthraquinone carboxylate (m.p. 130–131°), while vitamin A_1 yields a corresponding ester which is yellow (m.p. 123–124°). By treatment with alcoholic hydrochloric acid it forms the same anhydro compound (m.p. 76–77°)[3] as vitamin A_1, but the reaction proceeds much more slowly. It is more stable to atmospheric oxidation than vitamin A_1.

The constitution of the new vitamer has not yet been definitely established. The available evidence, however, suggests that it may be a geometrical isomer of vitamin A_1 differing in the *cis-trans* configuration at the double bond nearest the hydroxyl group.

A method has been developed for estimating the percentage of the new substance in fish liver oils and concentrates. This is based on the observation that maleic anhydride reacts more slowly with it in benzene solution than with vitamin A_1. Analyses of samples of soupfin shark and dogfish liver oil showed that 30 per cent and 33 per cent, respectively, of the vitamin A was the newly recognized compound.

A second method of estimation of the vitamer depends on the fact that it forms the anhydro compound on treatment with alcoholic hydrochloric acid much more slowly than vitamin A_1. The procedure is less useful than the one just described because it must be carried out on the saponified fish liver oil or concentrate.

A preliminary bio-assay on the new compound has indicated that its potency is nearly the same in kind and magnitude as that of vitamin A_1. More extensive assays are in progress.

The recognition that the vitamin A activity of fish liver oils is due to at least two different substances emphasizes the need for an improved system of nomenclature. The term 'axerophthol' proposed by Karrer for vitamin A_1 has not gained general usage and moreover establishes no basis for naming newly discovered vitamers. The use of subscripts is also unsatisfactory. For example, while the vitamin A_2 found in the liver oils from freshwater fish possesses curative powers for the vitamin A-deficiency syndrome, it probably has a basically different structural formula than vitamin A_1.

We have consulted various authorities in the United States and have suggested that the A-vitamins in fish liver oils be named from the genus of fish in which they were first found or in which they occur in concentrated form. Suggested terms were 'gadol' for vitamin A_1 from *Gadus*, the cod; and 'galol' for the new vitamer from *Galidæ*, the shark. If other A vitamins are discovered in the future they could be named readily by this system, which is now being considered by the Committee on Biochemical Nomenclature of the U.S. National Research Council.

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* The word 'vitamer' was introduced simultaneously by Dean Burke and associates of the National Cancer Institute and workers at Distillation Products, Inc., to indicate two or more substances which have the same ability to cure a single deficiency syndrome.

Antibiotic Action of an *Aspergillus* Strain against *Mycobacterium tuberculosis**

IN the course of investigations on the growth conditions of *Mycobacterium tuberculosis*[1], we have observed that contamination by an *Aspergillus* strain of cultures of *M. tuberculosis* human and bovine type resulted in a distinct inhibition of growth. Systematic experiments founded on this observation led to the preparation of filtrates from pure cultures of the mould, which were active against *M. tuberculosis* human and b vine type. A preliminary report of our results was presented to the Swedish National Society against Tuberculosis on October 1, 1943. In view of a recent communication by M. A. Soltys[2], we wish to report briefly our findings.

Our *Aspergillus* strain (the identification of which is not yet completed), when grown on a synthetic medium containing iron-, sodium- and magnesium-salts, glycerine and certain nitrogenous substances, such as asparagine, at *p*H 7·2 (phosphate buffer) and at 37° C., produces an antibiotic, which inhibits the growth of *M. tuberculosis* and of *Staphylococcus aureus*. No antibiotic is produced, when the mould is grown on a Czapek-Dox medium. Soltys states that his 'aspergillin' is inactive against *Staphylococcus aureus*; thus, the antibiotic present in our culture filtrates may be different from 'aspergillin'. The chemical properties so far investigated point to the non-identity of our product with the known antibiotics isolated from aspergillus cultures, such as glyotoxin, helvolic acid or patulin. A detailed account of these investigations will be published elsewhere.

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* Swed. Pat. Appl. 7748/43 (6 Nov., 1943).

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Inhibition of Mould Growth by *p*-Aminobenzoic Acid and the *n*-Butyl Ester

In tests conducted in these laboratories, *p*-aminobenzoic acid and the *n*-butyl *p*-aminobenzoate have shown definite reduction in rate of growth of three representative moulds (species of *Aspergillus*, *Penicillium* and *Byssochlamys*) growing on Czapek-Dox agar medium, *p*H 4. Inhibition in the case of the free acid was very marked (at least 50 per cent) at a concentration of 5·6 millimolar (mm.) and a reduction could still be detected, in the case of *Aspergillus*, as low as 0·18 mm. The butyl ester proved more effective, greater than 70 per cent reduction being observed at 1·0 mm. and a marked effect persisting as low as 0·14 mm.—the lowest concentration tested. In cases of the intermediate and lower concentrations of the free acid, the colonies remained regular in outline and maintained a steady though reduced rate of increase; concentrations 9·8 and 5·6 mm. gave rise to very irregular and fluctuating growth. With the higher concentrations of both substances, particularly of the *p*-aminobenzoic acid, an orange-yellow pigmentation was observed both in the mycelial felt and in the surrounding medium[1,2].

With interest largely focused on the anti-sulphonamide and growth-factor effects of *p*-aminobenzoic acid and the fact that these are shown at extreme dilutions, it is not surprising that observations of inhibition by this substance have been relatively few. Woods[3] has actually referred to a slight inhibition of bacteria at concentrations (unspecified) above 0·2 mm. Most workers have been concerned with lower maximum concentrations than this, although Mayer[2] does not report inhibition of *Mycobacterium tuberculosis* when working at concentrations as high as 7·3 mm. Tamura[4] has, however, found inhibition with *Bacterium tularense* at 0·5 mm. and complete absence of growth after eight days at 1·0 mm. Johnson *et al.*[5] found evidence of both stimulation and inhibition of luminescent bacteria according to the concentration of *p*-aminobenzoic acid in the different parts of the treated growth. Lee and Foley[6] have made the interesting observation that raised temperatures can cause inhibition of bacterial growth by *p*-aminobenzoic acid at concentrations as low as 0·01 mm., as well as failure to show anti-sulphonamide action. Lavor and Ferguson[7] record harmful effects on protozoa by concentrations of *p*-aminobenzoic acid (7·3–0·073 mm.), comparable with those reported above as effective against moulds.

Esters of *p*-aminobenzoic acid have also been regarded principally from the point of view of growth factor and anti-sulphonamide activity. These include simple alkyl esters[3,8,9] and local anæsthetics of the procaine type[10,11,12]. Kuhn *et al.*[9] include some results with such esters. Their experience of the butyl ester differs from ours with fungi, in that they report it, together with the ethyl, lauryl and cetyl esters, as having no bacteriostatic effect with *Streptobacterium plantarum* when studied up to approximately 12 mm. (This would, according to our experience, be greatly in excess of the solubility of the butyl ester.)

Other compounds related to *p*-aminobenzoic acid should be mentioned. Both Hirsch[13] and Kuhn *et al.*[9] have reported inhibition by *p*-aminobenzamide; the former found it almost as active as sulphanilamide at comparable concentrations, the latter noted growth accelerations at greater dilutions (0·007 mm.) but 50 per cent inhibition at 0·014 mm. Auhagen[14] reports relatively weak sulphonamide-like inhibition with *p*-aminoacetophenone and *p*-aminobenzophenone. Other workers[15,16] have studied a number of substituted *p*-aminobenzoic acids, and have found that according to the nature and position of the substituents, some of the compounds demonstrated sulphonamide-like bacteriostasis, some retained *p*-aminobenzoic acid properties, while others were practically inactive.

Such results as those reviewed above, taken with our own experience with moulds, suggest that more attention might be given to the inhibitory action of *p*-aminobenzoic acid and its derivatives. On one hand, increasing the concentration of *p*-aminobenzoic acid gives rise to definite inhibition. On the other, stimulation by sulphanilamide has been observed in low enough concentrations[5,17]. Compounds like sulphanilamide and *p*-aminobenzoic acid might profitably be regarded as members of the same broad biochemical group possessing a similar 'pattern' of inhibitory properties: showing quantitative rather than qualitative differences in their toxic behaviour.

Evidence of its toxic properties raises the question as to the form in which *p*-aminobenzoic acid is likely to occur in the cell. It seems probable that some at least is built into a larger 'non-toxic' molecule. Recently the existence of 'bound' forms of *p*-aminobenzoic acid in naturally occurring material has been postulated[18,19,20]. According to Blanchard's evidence[20] the amino group is likely to be involved in a peptide link. Ratner and others are reported[21] as having isolated from yeast a polypeptide containing one molecule of *p*-aminobenzoic acid and some thirteen molecules of *l*-(+) glutamic acid.

Further systematic investigations of *p*-aminobenzoic acid and related compounds are being conducted in these laboratories.

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Production of Kojic Acid by *Aspergillus effusus* Tiraboschi

IN 1942 Wilkins and Harris[1] reported that culture media on which the mould *Aspergillus effusus* Tiraboschi (National Collection of Type Cultures, No. 973) had grown inhibited the growth of *B. coli* and *Staph. aureus*. It has been found that, under cultural conditions to be described, the whole of the antibacterial activity can be attributed to the production of kojic acid. Owing to the weakness of its antibacterial properties this substance is not generally regarded as an antibiotic; its detection as such was due to its relatively high concentration in the culture fluid. Attention is directed here to kojic acid as an antibiotic because it is a common product of mould metabolism and may account for the inhibitory properties of a number of moulds not yet investigated in detail. Recognition of this possibility may prove time-saving to other workers.

Kojic acid is stated by Yabuta[2] to be produced in a high yield from various carbohydrate sources by *Aspergillus oryzæ*, *albus*, *candidus* and *nidulans*. It was obtained by Birkinshaw *et al.*[3] from *Aspergillus parasiticus* and *Penicillium dalecæ* Zaleski. The latter authors deduced its production also by *A. effusus* Tiraboschi, *A. tamarii* and *A. flavus* from the production of a strong wine-red colour on treating the crude medium with ferric chloride; but it should be noted that the mould products claviformin (produced by at least four fungal species) and aspergillic acid give a similar red colour with ferric chloride. The literature of kojic acid, up to 1934, has been reviewed by Barham and Smits[4], who mention its antibacterial properties.

The mould was grown at 24° C. in Erlenmeyer flasks on a medium of the following composition: maltose 40 gm., peptone 10 gm., malt extract 26 c.c., water 1 litre. The antibacterial activity of the medium, measured by the plate and cylinder method against *Staph. aureus*, reached a maximum at 12–14 days, thereafter diminishing rapidly. At that time yields of kojic acid averaged 8–9 gm. per litre.

Tested by the dilution method, kojic acid completely inhibited the growth of a strain of the following bacteria at the concentration shown:

> 1 : 400 < 1 : 800	*Proteus*, *Salm. enteritidis*, *Bact. coli*.
> 1 : 800 < 1 : 1600	*Salm. typhi*, *Staph. pyogenes*.
> 1 : 1600 < 1 : 3200	*Ps. pyocyanea* (2 strains).
> 1 : 3200 < 1 : 6400	*Ps. pyocyanea* (2 strains).

Unlike that of many other antibacterial substances, its potency was little affected by the number of bacteria present. A thousandfold increase in the size of the inoculum made little or no alteration in the inhibitory titre. Neither was the antibacterial activity reduced after incubation for three hours at 37° C. in 50 per cent serum.

For testing toxicity to animal tissues, solutions of kojic acid were neutralized with sodium hydroxide to *p*H 6·8 (which does not diminish the antibacterial activity of the solution). The toxicity to cells *in vitro* was estimated by its effect on human leucocytes[5]. In a 1 : 100 solution the cells became sluggish or stationary in half an hour and were nearly all dead in three hours. In 1 : 200 the movement of the majority was arrested in two hours but the cells did not die. The preparation in 1 : 400 did not differ significantly from control preparations. Dr. R. W. Ross informs us that a 1 : 400 solution did not interfere with phagocytosis by human leucocytes.

Sodium kojate produced characteristic signs when injected into mice by any route in a sufficiently large dose. The mouse became prostrate, the legs and tail stretched out stiffly and the breathing slow and laboured; the coat was not roughened. After the largest doses there was slight irregular twitching of muscle groups and a lethal dose produced convulsions before death. The duration of sickness was proportional to the size of the dose, and even after prostration lasting for two or three hours, recovery, if it occurred, was rapid and complete.

Friedemann[6] described similar effects on dogs, rabbits and rats, and gave the toxic dose (intravenous) as 150 mgm. per kgm. and the lethal dose as 1 gm. per kgm. The figures for mice are of the same order. In mice weighing from 20 to 23 gm., 5 mgm. injected subcutaneously, intraperitoneally or intravenously usually produced signs of toxicity, and 30–40 mgm. killed; by mouth 20 mgm. was without effect, 40 mgm. produced illness and 80 mgm. killed.

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A Twenty-four Hour Pregnancy Test for Equines

IN 1928 the Aschheim-Zondek Test for the diagnosis of human pregnancy in urine was introduced[1]. In 1930, B. Zondek proposed a modification of this test for the diagnosis of equine pregnancy in the blood and in the urine[2]. The blood test is only feasible, however, between the 42nd and 125th days of pregnancy, after which the equine gonadotropin disappears from the blood[3].

These pregnancy tests are based upon the gonadotropic reactions which have been classified (1926–27) as follows[4]:

Anterior pituitary reaction, I:	œstrus reaction in the mouse and rat.
Anterior pituitary reaction, II:	hyperæmia in the rat ovary, follicle hæmorrhage in the ovary of mouse and rabbit (blood dot).
Anterior pituitary reaction, III:	corpus luteum formation in the ovary of mouse, rat and rabbit.

Most characteristic is the follicle hæmorrhage appearing (as anterior pituitary reaction II) in the ovary of the mouse and rabbit, which has since been used for the diagnosis of pregnancy in man and equines. The reliability of pregnancy tests, based upon the gonadotropic reaction, is about 99 per cent. The only disadvantage of these tests is the long reaction time required: 6 days for the rat, 5 days for the mouse and 2 days for the rabbit.

It has recently been demonstrated that a reliable diagnosis of human pregnancy may be carried out within twenty-four hours, using the hyperæmic reaction of the infantile rat ovary (anterior pituitary reaction II). The test is based on the fact that within twenty-four hours (sometimes even two to six hours) following the injection of human pregnancy urine, the ovaries of the infantile rat undergo a strong

hyperæmic reaction, accompanied by swelling, as already described in 1927[4]. This is the earliest stage of gonadotropic reaction following the injection of gonadotropic hormone. It seemed possible that the rapid method as applied to the urine of pregnant women might be applicable as well to the blood of pregnant mares. In the latter, the diagnosis of early pregnancy by a veterinarian is difficult, and on the other hand it is important to the breeder to recognize pregnancy in its early stage in order to prevent abortion due to excessive work or strain.

The first thing to be established was whether the hyperæmia test is evoked by pregnant mare blood gonadotropin as it is by human pregnancy urine gonadotropin. The clarification of this point was of importance, as pregnant mare blood contains mostly the follicle-stimulating hormone and human pregnancy urine contains chiefly the luteinizing factor. We found the hyperæmia test to be quite sensitive for the detection of minute amounts of human pregnancy urine gonadotropin, 1 hyperæmia unit (anterior pituitary reaction II) equalling 1 œstrus unit (anterior pituitary reaction I). Unfortunately, the hyperæmia test (anterior pituitary reaction II) is not so sensitive for the detection of small amounts of pregnant mare blood gonadotropin, 1 hyperæmia unit (anterior pituitary reaction II) equalling as much as 10 œstrus units (anterior pituitary reaction I) and 3 luteinization units (anterior pituitary reaction III) of pregnant mare blood gonadotropin. The new method requires, therefore, 3–10 times the amount of hormone administered in the earlier pregnancy test[2] for equines, but it has the advantage of giving clear-cut results with 99 per cent reliability within twenty-four hours. It is possible to obtain a positive reaction with the hyperæmia test as early as 4–6 hours after injection of the equine gonadotropin. The reaction at this early stage is positive, however, only in 33–50 per cent of the animals, and whereas the positive reaction indicates pregnancy, negative results cannot be evaluated. Furthermore, the faint pink colour of the ovary, obtained after 4–6 hours, is not so convincing as the dark red appearance after 12–24 hours. Therefore, we prefer the 24-hour pregnancy test.

Technique : The mare or donkey is bled from the jugular vein and 20 c.c. serum are sent to the laboratory. If the specimen is sent through the post a few drops of phenol or preferably tricresol should be added to the serum. In the laboratory four rats 3–5 weeks old, 30–40 gm. in weight are injected as follows :

R.1 : 2·0 c.c.
R.2 : 1·5 c.c.
R.3 : 1·0 c.c.
R.4 : 0·5 c.c.
} twice daily, preferably at 2–4 hr. intervals.

R.1 is killed on the evening of the day of the first injection at least 6 hours after the first injection and 4 hours after the second injection.

R.2 and *R*.3 are sacrificed on the following day, about 18–24 hours after the first injection.

R.4 is sacrificed 5 days after the first injection, after having received 2 × 0·5 c.c. serum for 4 consecutive days, that is, a total of 4 c.c. serum.

The test is positive if at least both ovaries of one of the rats *R*.1–3 show a distinct red colour resembling that of the spleen or kidney. As a rule, all the rats react similarly. Autopsy of rat *R*.4 takes into consideration vaginal œstrus and corpus luteum formation as in the original Aschheim-Zondek test and serves for control purposes only. It detects all cases of early pregnancy or late pregnancy where the blood gonadotropin titre is lowered.

The hyperæmia test gives positive results with all sera containing more than 250 I.U. pregnant mare blood gonadotropin per litre. It may also be used for quantitative pregnant mare blood gonadotropin determinations since 1 hyperæmia unit, that is, the smallest quantity of serum evoking the rat anterior pituitary reaction II, equals about 1 I.U. It facilitates the preparation of pregnant mare blood gonadotropin by making possible the bleeding of pregnant mares at the peak of hormone production.

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A New Type of Phase Rule Solubility Test for Enzyme Purity

IN 1937 Kuhn and Desnuelle[1] prepared a highly purified specimen of Warburg's yellow enzyme, and as evidence of purity they pointed out that when ammonium sulphate was added to the solution the yellow colour and the protein began to come out of solution at the same salt concentration, and that the decrease in yellow colour and the decrease in protein content were parallel. They did not develop the test further, nor did they successfully apply it to the analysis of impure solutions.

From the work of Butler, Blatt and Southgate[2], Roche, Doriot and Samuel[3,4], and Jameson and Roberts[5], it is clear that when increasing quantities of a precipitating salt are added to a series of protein solutions, the appearance of a new solid phase will cause a break in the curve relating concentration of protein in solution to salt concentration. Further, Jameson and Roberts pointed out that such breaks in continuity were in accordance with the phase rule.

It is the object of this account to show that an analysis of the effect of increasing quantities of a precipitating salt on a protein solution can be used as a purity test for any protein with an accurately measurable specific quality.

The enzyme solution used in these studies was a highly purified solution of pig liver esterase, and the precipitating salt was ammonium sulphate. Increasing quantities of salt were added to equal volumes of enzyme solution, and after precipitation had ceased the solutions were filtered and the filtrates analysed for enzyme and for protein. The test consists in plotting these latter quantities against one another and analysing the result.

From the work of Cohn[6], we would expect a linear relationship between log solubility and ionic strength. It is therefore interesting to note that when plotted logarithmically, there is a double inflexion in the enzyme precipitation curve (graph 2), indicating the presence of two esterases the solid phases of which behave independently.

We can interpret graph 5 somewhat as follows. The fall in enzyme activity between *A* and *B* occurred before any protein precipitation took place, and is therefore probably due to denaturation on the air bubbles salted out by the ammonium sulphate. At *B*

the solution is saturated with respect to an impurity and the protein concentration decreases without any change in enzyme concentration to C, where the solution becomes saturated with respect to the enzyme. Between C and the origin the concentration of the impurity decreases with respect to that of the enzyme and the curve gradually straightens. The inflexion due to the precipitation of the second enzyme does not occur, probably because the activities of the two enzymes expressed as enzyme units per milligram of protein nitrogen are too close to show as a difference in slope.

If we assume Cohn's equation[6] and let S_I and S_E, β_I and β_E, and k_I and k_E, be the solubilities, intercept constants, and slope constants of the impurity and of the enzyme respectively, and if I be the ionic strength, we have:

$$\log S_I = \beta_I - k_I I \quad . \quad . \quad . \quad . \quad (1)$$

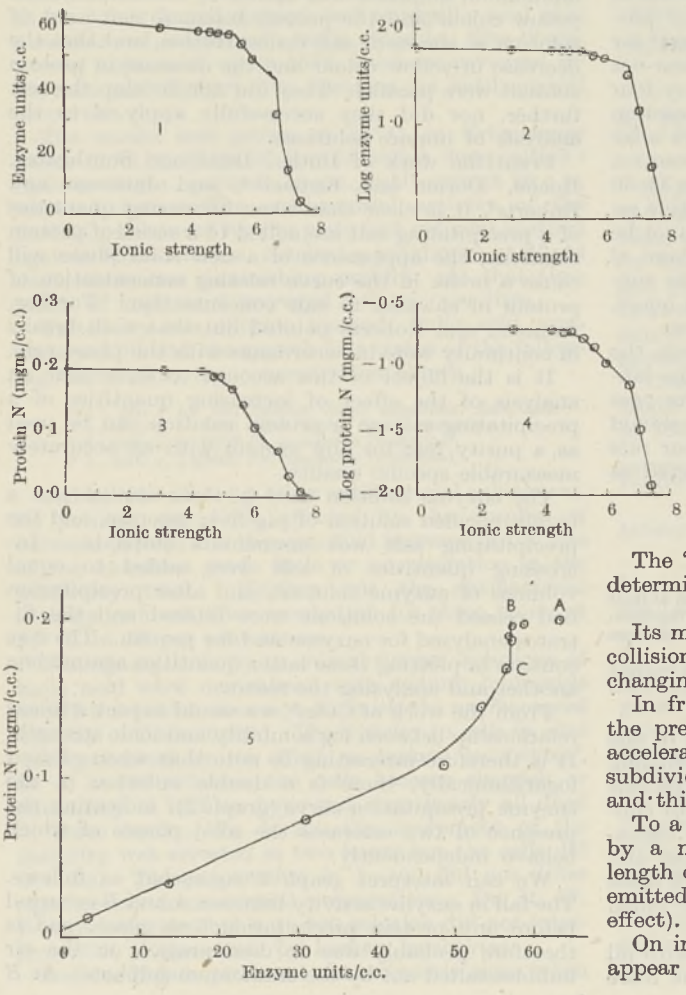
$$\text{and } \log S_E = \beta_E - k_E I \quad . \quad . \quad . \quad . \quad (2)$$

$$\therefore \quad S_I = e^{(\beta_I - k_I I)} \quad . \quad . \quad . \quad . \quad (3)$$

$$\text{and} \quad S_E = e^{(\beta_E - k_E I)} \quad . \quad . \quad . \quad . \quad (4)$$

Now since the protein concentration P at any point on graph 5 between C and the origin is equal to the sum of the protein solubilities, the equation to graph 5 must be:

$$P = e^{(\beta_I - k_I I)} + \frac{1}{K_E} e^{(\beta_E - \beta_E I)} \quad , \quad . \quad . \quad (5)$$



where the conversion constant K_E is equal to the activity of the pure enzyme expressed as enzyme units per milligram of protein nitrogen.

Equation 5 expresses the relationship between the enzyme and the impurity, and can be used to calculate the subsequent purification procedure.

It is clear that in the case of a pure substance, graph 5 would be a straight line passing through the origin.

It is a pleasure to express our indebtedness to both Dr. G. S. Adair and Dr. D. W. G. Style for their invaluable advice on many points.

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Structure of the Photon

BY analogy with the existence of both positive and negative electric charges, one may envisage the possibility of the existence of negative as well as positive mass. The non-appearance of such particles can be readily explained, but in at least one case the hypothesis leads to useful deductions.

Consider a particle of mass and charge both equal to those of the electron, but opposite in sign. In free space the behaviour of a doublet consisting of an electron and of this particle (termed provisionally the a-tron) shows considerable similarity to that of a photon.

When the electron and a-tron coincide, there is no resultant charge or mass; no external effects are observed and to all intents and purposes the doublet is non-existent. If the two particles are separated by a suitable amount of energy a force of attraction arises which accelerates the electron towards the a-tron, and the latter away from the electron (due to its negative mass). The doublet as a whole travels forward with as limiting velocity the velocity of light. The separation of the two particles determines the energy E of the doublet, but not its velocity.

The 'effective' mass M of the doublet in motion is determined by its energy E;

$$m = E/c^2 \quad (1)$$

Its momentum p ($p = E/c$) can be lost in part by collision with matter (Compton effect), without changing the limiting velocity c.

In free space the doublet behaves as a unit; in the presence of a positive gravitational mass it is accelerated bodily towards the latter. It cannot be subdivided without losing its fundamental properties, and this property it shares with the photon.

To a stationary observer the emission of a doublet by a moving body results in a change in wavelength due to the 'carry-on' of the electron, which is emitted after the emission of the a-tron (Doppler effect).

On interaction with matter, the doublet may disappear as a unit; for example, the a-tron may be

neutralized by an electron, thereby freeing the electron constituent of the doublet, together with a corresponding amount of energy (photo-electric effect).

The electromagnetic wave properties of the photon are paralleled by those of the probability waves of the doublet. The close analogy between them is demonstrated, for example, by the similarity in the laws of interference of electronic probability waves and of electromagnetic waves (electron and X-ray diffraction).

A photon of energy E has a wave-length $\lambda_p = hc/E$. A doublet of this energy has a de Broglie probability wave-length $\lambda_b = h/mc = hc/E$ (from equation 1). Thus the de Broglie probability wave-length of the doublet equals the electromagnetic wave-length of the photon in free space. Similarly, the velocity of the de Broglie waves ($u = c^2/v = c$) equals that of light. In a medium of refractive index other than unity this conclusion requires modification.

In free space the doublet can thus be represented by a sinusoidal probability wave, of wave-length λ and travelling with velocity c. The square of its amplitude at any point is proportional to the charge and mass at that point.

The electric and magnetic fields associated with the photon arise, not from this sinusoidal variation in electric charge, but from the magnetic moment due to electron (and a-tron) spin. At rest, the magnetic moments of electron and a-tron coincide and neutralize one another. In motion it is assumed that they are perpendicular to the direction of motion. At any point the sinusoidal variation in electric charge density gives rise to a corresponding variation of the magnetic moment (which is proportional to it), and hence to that of both magnetic and electric fields.

The direction of magnetic moment of the doublet may be indeterminate around the axis of propagation or it may be parallel to a given direction, etc. In the first case, the waves are unpolarized; in the second they are linearly polarized. Corresponding to the laws relating to the polarization of light are those relating to the spin of the electron and a-tron.

Further consideration of a duality of positive and negative masses appears capable of furnishing information on the nature of the electric field.

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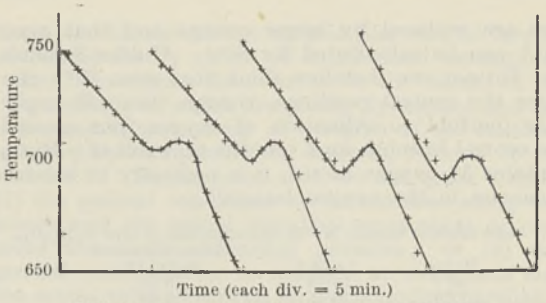
Polymorphy of Bismuth Trioxide

FROM thermal analyses, Guertler[1] concluded that bismuth trioxide, Bi_2O_3, existed in two forms, one stable above 704° C. and one stable below this temperature. He was not able to prepare the high-temperature modification even by quenching.

From the smoke of burning bismuth, Sillén[2] prepared a second form of bismuth trioxide, which was proved by X-ray analysis to be different from the ordinary form. This new phase was called β Bi_2O_3 and the ordinary form α Bi_2O_3, and it was assumed that β Bi_2O_3 corresponded to Guertler's high-temperature form. Schumb and Rittner[3] have also prepared the β-form and shown that it is transformed to the α-form below 710°. However, they believe that the transitions α $Bi_2O_3 \rightarrow$ β Bi_2O_3 and β $Bi_2O_3 \rightarrow$ α Bi_2O_3 are rather slow reactions, and that the transition



COOLING CURVES FOR BISMUTH TRIOXIDE POWDER.

point observed by Guertler was quite a different phenomenon, due to contamination of the molten oxide by the crucible employed.

Now if bismuth trioxide is heated to above 700° in a crucible of a resistant material and then allowed to cool, the mass is first seen to darken and then suddenly to glow, which strongly indicates the presence of a transition point. We have tried to investigate this transition under such conditions that contamination was practically excluded. A rather large quantity of pure bismuth trioxide was heated (in a platinum crucible) for about thirty minutes to below its melting point. The temperature was measured by means of a thermocouple inserted directly in the mass. The cooling curve very clearly shows a transition point at about 700° (see accompanying graph). Since the careful work of Schumb and Rittner has shown that the transition point of β $Bi_2O_3 \rightarrow$ α Bi_2O_3 is at about 710°, our experiments appear to indicate, in accordance with Guertler's, that the transition is more rapid than Schumb and Rittner have suggested.

When Guertler fused bismuth trioxide in a porcelain crucible, he obtained a new substance which he considered to be a third modification of the trioxide. Sillén also prepared this substance and found that it was isomorphous with a synthetic compound with a body-centred cubic cell containing $Si_2Bi_{24}O_{40}$. The latter seems to be built up by spheres of composition $SiBi_{12}O_{20}$ with Si in the centre. Similar compounds were prepared from Bi_2O_3 and Al_2O_3 or Fe_2O_3. Their composition may be $Me_2^{3+}Bi_{24}O_{39}$.

Schumb and Rittner have prepared a third form of bismuth trioxide called by them γ Bi_2O_3. Powder photographs and density measurements indicated a body-centred cubic cell containing $Bi_{26}O_{39}$. Though this cell is very similar to the body-centred cubic cell determined by Sillén, Schumb and Rittner do not consider the crystal structure to be the same. They hold that the differences in ionic radii between Bi^{3+} and the *Me* ions in $Si_2Bi_{24}O_{40}$ and similar compounds is too large to allow Bi^{3+} to be substituted for the *Me* ions.

We have prepared the γ Bi_2O_3, following the method of Schumb and Rittner. Their analyses did not entirely exclude the possibility that some of the bismuth is pentavalent, and the formula $Bi_{26}O_{40}$ did not seem improbable by analogy with $Si_2Bi_{24}O_{40}$. We therefore analysed for Bi^{5+}, but within the limits of error we found none. Consequently, the unit cell of γ Bi_2O_3 probably contains $Bi_{26}O_{39}$. Since the work of Sillén, Aurivillius has investigated a number of metal bismuth oxides seemingly isomorphous with $Si_2Bi_{24}O_{40}$. A summary is given below. Hitherto no mono- or divalent ions have been found to enter the central positions of Si^{4+}. The table shows that the lattice dimensions grow larger when the Si^{4+}

ions are replaced by larger cations and that even Ce^{4+} can be substituted for Si^{4+}. Unlike Schumb and Rittner, we therefore think that even Bi^{3+} can enter the central positions, though this will imply only fourfold co-ordination of oxygen ions around the central bismuth ions. As the unit cell of γ Bi_2O_3 contains 39 oxygen atoms, it is necessary to assume vacancies in the oxygen lattice.

Cube edges of various *Me*–Bi–O compounds of type $Si_2Bi_4O_{10}$.

Metal	a (A.)	Ionic radius of metal (A.)
Al^{3+}	10·14	0·53
Tl^{3+}	10·15	1·00
Fe^{3+}	10·16	0·67
Bi^{3+}	10·243	1·0
Si^{4+}	10·08	0·40
Ce^{4+}	10·20	1·02
Zr^{4+}	10·21	0·83
Pb^{4+}	10·23	0·84

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Bottom Deposits of the Red Sea

DURING the Egyptian Preliminary Expedition to the northern Red Sea in the R.R.S. *Mabahith* during 1934–35, which I accompanied, some sixty bottom-samples were collected, in particular from the three differently constituted areas, the Gulf of Suez, the Gulf of Aqaba and the Red Sea proper[1,2]. The mechanical composition and mineralogy of the bottom sediments were recently examined in the Department of Geology, Faculty of Science, Cairo.

The Red Sea is unique among the seas of the world in the fact that no permanent streams flow into it, and that only winds, mostly north-westerly, and occasional rain-torrents contribute material to its bottom. The sea is probably unique also for the very irregular bottom topography (excluding the Gulf of Suez); hence the nature and distribution of its bottom deposits are unmatched in other seas.

The sediments are coarser and better sorted, when they are secured from shallow or sloping bottoms (being finer in basins than on ridges and slopes) or from near land masses (including submarine ridges)[3]. The topography of the bottom seems to be the important factor in determining the physical constitution of the deposits. The irregular topography of the bottom gives rise to variety in the sediments. Contrasts appear between the deposits of the shallow and smooth Gulf of Suez, the deeper Gulf of Aqaba and the very irregular Red Sea proper. The Gulf of Suez, because of its flat bottom, has deposits with but little variation in their statistical data, in contradistinction with deposits on the very irregular bottom of the Red Sea, which have rapid changes in the corresponding statistical constants. The difference in environment is also shown by the fact that the sediments of the Gulf of Suez, though of shallow origin, are finer and less sorted than those of the Gulf of Aqaba or the Red Sea shallow environments. The peculiarity of the Gulf of Suez is also reflected in the mineralogy of its sediments, which are much richer in authigenic pyrites than either the Gulf of Aqaba or the Red Sea. The Gulf of Suez sediments are, in fact, comparable with normally sorted sediments from continental shelves; the Gulf of Suez is itself a shallow flat shelf filled with surface water of the Red Sea and descending at its mouth abruptly to a depth five times greater than its own. It is to be noted that the chemistry of the bottom deposits showed contrast in the three main regions investigated[4].

The mineralogy of the sediments is uniform over the different provinces and thus contrasts with that of the usual basins of deposition. Local variations are, however, caused by contamination from local source rocks or variation in the environmental conditions of deposition[5]. Such uniformity in the mineralogy of the Red Sea bottom sediments, which are mainly carried by wind, and the absence of sedimentary petrographic provinces, are the main characteristics of wind-borne detritals. The conclusions of Sujkowski, who examined bottom deposits from the middle and south-eastern parts of the Sea, that the characteristic of the deposits, because of the absence of any chemical decomposition and lack of water transportation, is the presence of the easily weathered, coloured minerals and the common rock-forming minerals of crystalline rocks in abundance in a fresh state[6], are invalid as he overlooked the factor of provenance. The recent dunes of the great African Sahara, where conditions that favour mechanical disintegration rather than chemical decomposition of source rock prevail, but where sediments and not crystalline rocks dominate, contain a totally different assemblage (poor in the common rock-forming minerals: pyroxenes, amphiboles, micas and felspars) from that of the Red Sea[7]. On the other hand, the Nile sediments, which are water-borne, gave an assemblage of minerals with the same characteristics as those of the Red Sea bottom deposits[8]. Both formations, though of two different modes of origin, are remarkable examples of the richness of recent sediments (derived from crystalline rocks) in vulnerable minerals. The statement of White[9] that wind-borne sands contain less frequent heavy minerals than water-borne sands, and that the heavy minerals are less frequent in larger deserts than in smaller desert areas, is invalid as he did not take into account the factor of provenance in this case also.

The mineral assemblage of a sediment depends, in fact, on the following three main factors, which should be collectively taken into account when the nature of the assemblage is to be explained: (1) nature of distributive rocks; (2) type of weathering and mode of transportation; (3) post-depositional processes, leading to simplification of detrital grains[10].

The mineralogy of the clay fractions of the bottom deposits is, at present, under investigation.

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TIDES OF THE ATLANTIC OCEAN

PROF. J. PROUDMAN, professor of oceanography in the University of Liverpool, delivered the George Darwin Lecture at the Royal Astronomical Society on October 13, 1944, the subject of his lecture being "The Tides of the Atlantic Ocean" (*Mon. Not. Roy. Ast. Soc.*, 104, 5, 244; 1944).

Prof. Proudman gave a short history of the problem, starting with Whewell, who published the first co-tidal charts in 1833, which were based on reasoning of a largely non-dynamical character. Whewell's deductions that the tides of the Atlantic were generated in the Southern and Pacific Oceans, which Airy rejected and which Whewell himself had abandoned by 1848, continued, unfortunately, to be repeated for a long time in text-books. In 1874 Ferrel calculated, on dynamical principles, what the tides would be in canals along parallels of latitude stretching from one side of the Atlantic to the other. He thought that there might be an approach to conditions of resonance for a canal between Ireland and Newfoundland, and if a dyke extended from the Cape of Good Hope to the coast of South America, the tides in the North Atlantic would probably be very nearly the same as they actually are. In 1900 Harris took up Ferrel's work, and four years later constructed charts of co-tidal lines for all the oceans and seas; but as Proudman points out, his work involved a number of serious errors, among which may be noticed a mathematical mistake involving an error of three hours in the times of high water; the neglect of the resonance of transverse oscillations for the South Atlantic; lack of consideration of the effect of water in neighbouring regions; and failure to give adequate consideration to the dynamical effects of the earth's rotation.

In 1910 Poincaré discussed the energy implications of progressive waves, and in applying his principle regarding the influx of energy into any region and the forces which must balance it, he concluded that, in the arctic seas, the dissipation of energy by the friction of tidal currents on the sea bottom was always negligible; that the work done against the generating force was also negligible; and that the flow of energy out of the region was insignificant on account of the smallness of the Bering Strait. He therefore deduced that the arctic tides do not consist of a wave progressing from the Atlantic, but, as Taylor showed in 1918 and Jeffreys in 1923, friction is by no means negligible in shallow seas, and Poincaré's arguments could not be maintained.

A brief reference is made to Sterneck's co-tidal charts, which are not based on dynamical principles, but on observation; and then Defant's work is considered at length. Defant abandoned his work of 1924 in 1932 and confined his attention to the neighbourhood of the central line of the ocean and also to the part of the Atlantic south of Iceland. He started by assuming that the rotation of the earth does not affect the tidal conditions on the central line; that the transverse generating forces do not affect tidal conditions on the central line; and that there is no dissipation of energy to the south of Iceland. He considered two phases, differing by a quarter period, such that they agree with observations at the Azores and Tristan da Cunha, the node of one phase coinciding with the loop of the other, and his results show good agreement with the observations on these islands. Although Defant's assumptions cannot be regarded as anything more than rough approximations, conditions on the central line can be largely accounted for by means of longitudinal oscillations.

Prof. Proudman then turned to the results of his own researches, which are purely dynamical and are concerned with a study of a region of the Atlantic bounded by two parallels of latitude, those of 45° N. and 35° S. He supposes that we are given either: (1) the general conditions to be satisfied along the coasts and the actual meridian-components of currents across the bounding parallels; or (2) the general conditions to be satisfied at the coasts and the actual tidal elevations on the bounding parallels; or (3) the general conditions to be satisfied at the coasts and the actual meridian-components of the currents on one bounding parallel and the actual elevations on the other bounding parallels. Then the tidal elevations and currents are mathematically determinate all over the region considered, including their values on the coasts. As we do not know the actual currents or the actual elevations or the bounding parallels, but we know the coastal elevations, the problem is considered the other way round. Given the general conditions along the coasts and the actual values of coastal elevations, the tides are mathematically determinate over the whole region considered, and Prof. Proudman solves the problem by considering a number of subsidiary problems of a different type, but limits of space prevent a detailed account of these, and a short summary of his work must suffice.

Selecting the parallel of 35° S. as the one along which certain conditions are prescribed, and taking the elevations and meridian components of current to be zero along this parallel, but allowing for all the generating forces, one particular solution is obtained. While the resulting oscillation is small in the South Atlantic, there are larger amplitudes in the North Atlantic, and a large co-tidal area exists here. A second particular solution is an oscillation which Prof. Proudman calls a north-going Kelvin-wave, and corresponds to currents along the meridians and to elevations, both of which increase exponentially towards the west. Considerable complications are produced by the curvature of the earth along the meridians, by variations in the width of the oceans and by variations in depth. A third solution gives a south-going Kelvin-wave, and again the currents in latitude 35° S. are along the meridian, but in this case both the elevations and currents increase exponentially towards the east. By assuming that the transverse currents follow a sine-distribution from coast to coast, two other solutions, called the north-going and the south-going Poincaré-wave, are obtained, and in these cases the amplitudes are small in the centre of the ocean.

The problem is to assign an amplitude and a time-origin to each Kelvin- and Poincaré-wave, so that when the four are added to the forced oscillation, the coastal elevations in the synthesis will agree with observations so far as possible. Prof. Proudman has made the sum of all the waves agree with observation at four points on the coasts, and he has chosen two of these points in latitude 32·5° S. and the other two in latitude 7·5° S., that is, south of the Gulf of Guinea and Cape San Roque, where the major irregularities of the basin begin. The north-going Kelvin-wave is the most important with an amplitude of 52 cm. and a high-water time of 1·8 hr. at the south-west corner of the region considered. The south-going Poincaré-wave is the next most important; it has an amplitude of 35 cm. and a high-water

time of 9·1 hr. at the south-west corner. The other two free waves have each an amplitude of 22 cm. at the south-east corner, and the high-water time of the south-going Kelvin-wave at this point is 10·8 hr., and that of the north-going Poincaré-wave 0·5 hr. The agreement with observation is good as far as 5° S. latitude, but considerable divergences set in afterwards. Part of this divergence may be due to not including a sufficient number of Poincaré-waves, and Prof. Proudman hopes to obtain better results by including more of these waves than he has done in the present investigations.

PLANT DISEASE AND THE WEATHER

CLIMATE exerts an important influence on the spread and severity of plant disease—an influence long recognized, though not yet fully investigated. Some recent progress in this field was discussed in a symposium arranged by the Department of Plant Pathology of the West of Scotland Agricultural College at Auchincruive on November 8. The meeting was attended by the advisory pathologists for Scotland, the staff of the Plant Pathology Service of the Department of Agriculture for Scotland, members of the College staff, of the University of Glasgow and the Hannah Dairy Research Institute.

Dr. C. E. Foister, head of the Plant Pathology Service of the Department of Agriculture for Scotland, opened by a short review of progress since the Conference of Empire Meteorologists in London in 1929. It becomes increasingly clear that records taken with ordinary meteorological exposure do not provide the pathologist with all the data he requires. It is necessary to study weather within the crop, and to follow up such information by investigations with artificially controlled conditions. Physiological races of fungi, moreover, may react differently to weather conditions. The distribution and occurrence of yellow rust of wheat in Scotland, for example, suggests the existence of different races varying in their reaction to environmental factors. Several parasitic fungi, common in England and Wales, are rare or unknown in Scotland, or confined to certain areas there. They include *Puccinia triticina*, *Septoria tritici*, *Rhynchosporium secalis*, *Phytophthora cactorum*, *Diaporthe umbrina*, *Heteropatella antirrhini* and the Dutch elm disease.

The rhododendron bug has twice invaded Scotland, but has failed to establish itself. How far are these apparent absences due to weather?

Dr. John Grainger, head of the Plant Pathology Department at Auchincruive, considered the aerial climate, the soil climate and the major effects of weather, with special reference to work carried out at Auchincruive in 1944. He showed how daily averages of aerial temperature and humidity inspired further work; but only continuous records within the crop revealed true phenological relationships. Chocolate spot of the field bean, bean leaf spot (*Ascochyta fabæ*), and *Erysiphe graminis* on oats, all showed some increase of attack with rising relative humidity; but the real correlation was between disease intensity and the number of hours per day with complete saturation. Drain-gauge studies at Auchincruive have shown the large amount of rainfall evaporated from the soil. One aspect of aerial climate often neglected is that of conditions of storage for seed; it might be possible to provide conditions under which the parasites lose their viability before the seed. The major effects of weather are mainly important in so far as they transport fungal spores from one area to another. It has been found, however, that large teleutospores of some rust fungi are not carried more than a few yards by wind. Climate cannot, of course, be controlled, but the practical value of weather studies lies in the following points: (1) its value in life-history and mycological studies; (2) its help in raising immune or resistant crop varieties; (3) virus-infected crops should be rogued within such temperature limits as the symptoms are not masked; (4) the time of farming operations can be adjusted to avoid some infections; (5) excessive atmospheric humidity may possibly be controlled in some parts of Scotland by adequate drainage; (6) conditions of seed storage may be devised to minimize seed-borne disease; (7) growers may be advised when to spray in order to eliminate disease epidemics.

The role of weather as direct pathogen in causing frost damage to fruit blossom was discussed by Dr. C. E. Cornford, of the Midland Agricultural College. Field experiments with orchard heaters were described which showed that the hot air they supplied was chilled or warmed by several other agents. These included katabatic winds, altitude, the amount of cloud, the presence or absence of large dense grass exposed to the sky, the humidity of the air and the dryness of the trees and soil.

Dr. B. T. Cromwell (Auchincruive) presided over the discussion which followed. Mr. A. Heddle (Edinburgh) contrasted the epidemic of yellow rust in 1943 with its scarcity in 1944. The problem is complicated by the long growing-period of winter wheat. Dr. Mary Noble (Edinburgh) and Dr. Elizabeth Gray (Aberdeen) then contributed, and it appeared that winter wheat was generally much more susceptible than spring wheat in Scotland, and the severity of epidemics when they did occur was such that further detailed experiment was advisable. Dr. Grainger answered questions on frost damage in Dr. Cornford's absence. His own experience showed that oil heaters only raised the temperature of the air in their immediate neighbourhood by about 4° F. Evaporation from the buds lowered their internal temperature by 2° F., giving a net internal rise of about 2° F. Trials with humidified heating raised the air temperature near the source by 2° F., without internal cooling, thus resulting in a very considerable saving of fuel. Mr. Dovaston (Auchincruive) raised the question of avoiding grass cover in orchards subject to frost damage, but Dr. Cromwell and Mr. R. D. Reid (Auchincruive) held that grassing down was a very practical method of maintaining nutritional balance of the trees, particularly with regard to nitrogen.

Dr. Foister, Dr. Cromwell and Mr. Reid considered the occurrence of *Cladosporium* mould in tomato glasshouses. The disease was often more severe in low-lying houses on sandy soil than in higher situations on heavy soil; the factor of humidity did not seem to be the only one, and the admission of ultra-violet rays through 'Vita' glass did not eliminate the fungus. This discussion again pointed to the need for more detailed work. Dr. R. Laird (Ayrshire) mentioned that *Ascochyta fabæ* and chocolate spot were more severe in low-lying, sheltered fields, but remembered that certain periods when these diseases were spreading were characterized by hot, dry days. Dr. Grainger explained, however, that long periods of complete

saturation occurred during the nights at that time—a fact which again stressed the value of continuous records within the crop. Dr. C. L. Whittles (Auchincruive) urged the necessity for continuous records of such soil factors as *p*H, water content, conductivity and oxidation-reduction potential.

INDUSTRIAL DEVELOPMENT IN AUSTRALIA

THE paper "Scientific Aspects of Australia's Industrial Development", which Mr. G. B. Gresford read before the Royal Society of Arts on January 16, naturally covers a good deal of ground in common with the annual reports of the Commonwealth's Council for Scientific and Industrial Research, though the account is rather more up to date and in a larger setting. Mr. Gresford referred particularly to the recent plans of the Australian wool industry, stimulated no doubt by competition from artificial fibres, for a large expansion of scientific research. Part of the large sum which the Australian Wool Board proposes to raise by increasing the levy on growers of wool would be spent by the Council for Scientific and Industrial Research on biological and textile research, and part would go towards economic research and publicity. Whether or not the opinion is justified that fundamental research will lead to the improvement of wool yield and quality, the cheapening of processing and the development of new and novel fabrics so that wool can more than hold its own, the link between science and the wool industry will become closer.

After a reference to research in connexion with grain crops such as wheat, and the significance of the results in the field of nutrition and developments in the manufacture of fertilizers and sulphuric acid, Mr. Gresford mentioned particularly the part science has played in the development of the mining and metal industries. Investigations on flotation, and particularly the discovery of the collecting properties of potassium ethyl xanthate for the sulphide minerals, have led to the present high recoveries of lead and silver in the flotation sections of the mines. The work at the University of Melbourne on fundamental physical chemistry of the flotation process, which for ten years before the War was financed by a group of Australian mining companies, is now partly carried on by the Council for Scientific and Industrial Research. Work in new fields has suggested possible extensions of the flotation process to the concentration of new minerals. Mr. Gresford also referred to the continuous lead refining process for dressed smelter bullion evolved by the staff of the Broken Hill Associated Smelters as a striking example of the application of physical chemistry to an industrial process.

The paper industry, and particularly the development of processes for a wide range of papers from eucalyptus woods by a chemical or mechanical method, provides a further example of the solution by scientific research of a problem deemed intractable, and which has now made the Australian industry almost entirely independent of imported materials. Referring to the universities as sources of supply of scientific personnel for industry, Mr. Gresford said that the demand at present greatly exceeds the supply, and if maintained it will involve a corresponding expansion of the universities. Plans have been made for a considerable expansion of Government research activities, but further expansion of research in industry is desirable. So far, scientific exploration has not revealed any sources of flow oil in Australia; attention has not been given to the synthetic production of liquid fuels from coal, although the brown coal deposits of Victoria are very similar to those used in Germany for this purpose. Organic chemical industry on a large scale has scarcely been started and the development of the chemurgic industries, utilization of agricultural wastes, alkaloids and essential oils are other fields awaiting the application of scientific methods in Australia.

SYNTHESIS OF BIOTIN

A SYNTHESIS of biotin by S. A. Harris, D. E. Wolf, R. Mozingo, R. C. Anderson, G. E. Arth, N. R. Easton, D. Heyl, A. N. Wilson and K. Folkers, of the Research Laboratory of Merck and Co., Inc., has recently been described (*J. Amer. Chem. Soc.*, **66**, 1756; 1944).

The process involves several steps: *l*-cystine is reduced in liquid ammonia with sodium and coupled with chloroacetic acid to give β-(carboxymethylmercapto)-alanine, subsequent benzoylation and esterification of which yielded the dimethyl ester of N-benzoyl-β-(carboxymethylmercapto)-alanine. The diethyl ester was obtained by condensing thioglycolic ester with the ethyl ester of N-benzoyl-β-chloroalanine, derived from N-benzoylserine by esterification and chlorination with thionyl chloride. The dimethyl ester was treated with sodium methoxide in methanol to give the radium salt of 4-benzamido-3-ketotetrahydro-2-thiophenecarboxylic acid methyl ester, racemization occurring during the reaction. The sodium salt was hydrolysed and decarboxylated in an aqueous acetic acid – hydrochloric acid solution to give 4-benzamido-3-ketotetrahydrothiophene. The valeric acid side-chain was introduced by means of an aldehyde prepared from glutaric acid. The acid was converted in turn to glutaric anhydride, glutaric acid monomethyl ester, γ-carboxymethoxybutyryl chloride, and finally to methyl γ-formylbutyrate by a Rosenmund reduction.

The aldehyde ester, condensed with the ketone, 4-benzamido-3-ketotetrahydrothiophene, with piperidine acetate as catalyst, yielded the methyl ester of 4-benzamido-3-keto-$\Delta^{2,\delta}$-tetrahydro-2-thiophenevaleric acid, which reacted with hydroxylamine hydrochloride in pyridine to yield the methyl ester of 4-benzamido-3-oximino-$\Delta^{2,\delta}$-tetrahydro-2-thiophenevaleric acid, reduction of which by zinc dust in an acetic acid – acetic anhydride mixture gave two compounds, one the methyl ester of 3-acetamido-4-benzamido-4,5-dihydro-2-thiophenevaleric acid. Hydrogenation of this over a palladium catalyst and fractional crystallization of the products gave two racemates of the methyl ester of 3-acetamido-4-benzamidotetrahydro-2-thiophenevaleric acid. Each of these was hydrolysed with barium hydroxide, and subsequent treatment of the products with sulphuric acid gave the corresponding sulphates of the 3,4-diaminotetrahydro-2-thiophenevaleric acids.

The acids, when treated with phosgene, yielded two racemates of hexahydro-2-oxo-1-thieno[3,4] imidazole-4-valeric acid, which will be called *dl*-biotin, and *dl*-allobiotin. The *dl*-biotin was resolved through its esters with *l*-mandelic acid to give biotin.

FORTHCOMING EVENTS

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

Saturday, March 10

INSTITUTE OF PHYSICS (SOUTH WALES BRANCH) (in the Physics Department, University College, Swansea), at 2.30 p.m.—Inaugural Meeting. Dr. C. Sykes: "Physics in Metallurgy".*

Monday, March 12

FARMERS' CLUB (at the Royal Empire Society, Craven Street, Strand, London, W.C.2), at 2.30 p.m.—Mr. Geoffrey Crowther: "An Economist Looks at British Agriculture".

ROYAL INSTITUTE OF CHEMISTRY (in the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 4 p.m.—Annual General Meeting.

SOCIETY OF CHEMICAL INDUSTRY (YORKSHIRE BRANCH) (in the Metropole Hotel, King Street, Leeds), at 6.15 p.m.—Mr. S. W. Butterworth: "Flour"; Mr. E. F. Eaton: "Colours in Foods".

ROYAL INSTITUTE OF CHEMISTRY (joint meeting with the INSTITUTION OF RUBBER INDUSTRY) (in the James Watt Institute, Birmingham), at 7 p.m.—Dr. W. J. S. Naunton: "Rubber Chemicals—Past and Present Influence on Synthetic Rubber".

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, South Kensington, London, S.W.7), at 8 p.m.—Mr. Christopher Sandeman: "Northern Highway of Peru".

Tuesday, March 13

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Sir Henry Dale, O.M., Pres.R.S.: "Nerve Endings and Chemical Transmitters"; (2) "Adrenaline and Acetylcholine; Adrenergic and Cholinergic Nerves".

INSTITUTION OF ELECTRICAL ENGINEERS (RADIO SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Colour Television" (to be opened by Mr. L. C. Jesty).

ROYAL PHOTOGRAPHIC SOCIETY (SCIENTIFIC AND TECHNICAL GROUP) (at 16 Prince's Gate, South Kensington, London, S.W.7).—Dr. H. Baines: Presidential Address.

Wednesday, March 14

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr. J. H. O. Bunge: "The Thames Barrage and its Importance in the London Reconstruction Plans".

SOCIETY OF CHEMICAL INDUSTRY (FOOD GROUP, MICROBIOLOGICAL PANEL) (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Miss E. M. L. Elliot: "Bacteriological Aspects of the Laboratory Examination of Meat"; Mr. L. B. A. Grace: "Aspects of Practical Meat Inspection".

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

ROYAL METEOROLOGICAL SOCIETY (in the small Physics Lecture Theatre, Royal College of Science, Imperial Institute Road, London, S.W.7), at 4.30 p.m.—Major H. C. Gunton: "Report on the Phenological Observations in the British Isles from December 1943 to November 1944".

INSTITUTE OF PETROLEUM (in the Lecture Theatre of the Royal Society of Tropical Medicine, 26 Portland Place, London, W.1), at 4.30 p.m.—Thirty-second Annual General Meeting.

INSTITUTION OF ELECTRICAL ENGINEERS (TRANSMISSION SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. W. Kidd and Mr. E. M. S. McWhirter: "Operational Control of Electricity Supply Systems".

SOCIETY OF CHEMICAL INDUSTRY (SOUTH WALES SECTION) (joint meeting with the ROYAL INSTITUTE OF CHEMISTRY) (at the Technical College, Newport, Mon.), at 6.45 p.m.—Dr. H. E. Crossley "The Nature and Significance of the Inorganic Substances in Coal"

Thursday, March 15

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Prof. E. K. Rideal, F.R.S.: "Reactions in Monolayers" (Liversidge Lecture).

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Sir Lawrence Bragg, F.R.S.: "Some Physical Problems of the Solid State".

BRITISH INSTITUTE OF RADIOLOGY (in the Reid-Knox Hall, 32 Welbeck Street, London, W.1), at 8 p.m.—Mr. L. Dudley: "The Development of Stereoscopic Photography and Radiography".

Friday, March 16

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5 p.m.—Mr. J. Z. Young "The Structure, Degeneration and Repair of Nerve Fibres".

BRITISH INSTITUTE OF RADIOLOGY (in the Reid-Knox Hall, 32 Welbeck Street, London, W.1), at 5 p.m.—Special General Meeting.

INSTITUTION OF ELECTRICAL ENGINEERS (MEASUREMENTS SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Dr. G. F. Tagg: "The Temperature Compensation of Indicating and Recording Instruments".

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—"Invention after the War" (to be introduced by Mr. Harold Sinclair, Mr. E. W. Moss and Mr. H. W. Cadman).

Saturday, March 17

BIOCHEMICAL SOCIETY (at the Middlesex Hospital Medical School, London, W.1), at 2 p.m.—Annual General Meeting.

INSTITUTION OF MECHANICAL ENGINEERS (GRADUATES' SECTION) (at Storey's Gate, St. James's Park, London, S.W.1), at 3.30 p.m.—Mr. A. H. Lloyd: "British Machine Tools during the War" (Annual Lecture).

ROYAL PHOTOGRAPHIC SOCIETY (SCIENTIFIC AND TECHNICAL GROUP) (at 16 Prince's Gate, South Kensington, London, S.W.7).—Mr. L. V. Chilton: First Renwick Memorial Lecture.

APPOINTMENTS VACANT

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

LECTURER IN ELECTRICAL ENGINEERING for National Diploma and Higher National Certificate Courses in the Crumlin Mining and Technical College—The Director of Education, County Hall, Newport, Mon. (March 16).

LECTURER (full-time) IN ENGINEERING SUBJECTS—The Acting Principal, Technical Institute, Clowne, Chesterfield (March 17).

ASSISTANT BIOCHEMIST—The House Governor, General Hospital, Birmingham, 4 (March 17).

ASSISTANT CIVIL ENGINEER (permanent) by West Ham County Borough to take charge of the Civil Engineering Section of the Borough Engineers 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. E.1426.XA) (March 20).

METALLURGIST of Degree standard by large Engineering concern in S.E. England—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.3537.XA) (March 21).

LECTURER (non-resident) IN GEOGRAPHY, with some MATHEMATICS—The Principal, Diocesan Training College, Salisbury (March 24).

LECTURER (full-time) IN THE DEPARTMENT OF ELECTRICAL ENGINEERING, and a SCIENCE LECTURER (full-time) in the DEPARTMENT OF BUILDING, of the Liverpool Technical College—The Director of Education, 14 Sir Thomas Street, Liverpool, 1 (March 24).

TECHNICAL INSPECTOR AND GRADER IN THE MILK PRODUCT DIVISION of the Ministry of Food at Colwyn Bay—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.3397.A) (March 26).

LECTURER IN SPINNING—The Registrar, College of Technology, Manchester, 1 (March 28).

ASSISTANT BACTERIOLOGIST (temporary), and LABORATORY ASSISTANT IN BACTERIOLOGICAL SECTION OF LABORATORIES (temporary)—The Clerk to the Board, Metropolitan Water Board, New River Head, Rosebery Avenue, London, E.C.1 (endorsed "Assistant Bacteriologist" or "Laboratory Assistant" as the case may be) (March 31).

PRINCIPAL OF THE COUNTY MINING AND TECHNICAL SCHOOL, Nuneaton—The Organizer of Further Education, Council House, Nuneaton (March 31).

PRINCIPAL OF THE LEIGH MUNICIPAL COLLEGE—The Secretary of the Local Higher Education Committee, Education Department, Town Hall, Leigh, Lancs. (March 31).

SENIOR ASSISTANT IN THE COLLEGE LIBRARY—The Registrar, King's College, Newcastle-upon-Tyne (March 31).

LECTURER IN GENETICS—The Secretary of University Court, The University, Glasgow (April 7).

READER IN BOTANY AND HEAD OF THE BOTANY DEPARTMENT, tenable in the Durham Division of the University—The Registrar, The University, 46 North Bailey, Durham (April 14).

PROFESSOR OF ECONOMICS—The Registrar, University College, Singleton Park, Swansea (April 21).

REGISTRAR—The Bursar (acting Registrar), The University, Leeds, 2 (April 30).

SEDLEIAN PROFESSORSHIP OF NATURAL PHILOSOPHY—The Registrar, The University, Oxford (June 2).

ASSISTANT IN THE DEPARTMENT OF AGRICULTURAL ECONOMICS under the Ministry of Agriculture Advisory Scheme—The Secretary and Bursar, Seale Hayne Agricultural College, Newton Abbot, Devon.

METALLURGISTS (2) to undertake research in the welding of light alloys—The Secretary, British Welding Research Association, 2 Buckingham Palace Gardens, London, S.W.1.

LECTURER IN SCIENCE (mainly BIOLOGY)—The Principal, Training College, Hereford.

LECTURER (woman) to develop courses in GARDENING and RURAL SCIENCE, and a LECTURER (part-time) with suitable qualifications and experience to undertake with the students VOICE PRODUCTION, SPEECH TRAINING and SPEECH THERAPY—The Principal, St. Mary's College, Cheltenham.

TEACHER (full-time) OF MATHEMATICS—The Principal, Enfield Technical College, Queensway, Enfield, Middx.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

London School of Hygiene and Tropical Medicine, incorporating the Ross Institute. Report on the Work of the School for the Year 1943–44. Pp. 44. (London: London School of Hygiene and Tropical Medicine, 1945.) [92

Co-operative Electrical Research. Pp. 62. (London: British Electrical and Allied Industries Research Association, 1944.) [92

Tory Reform Committee. Bulletin No. 9: Approved Societies. Pp. 4. (London: Tory Reform Committee, 1945.) [92

Catalogues

Technical and Scientific Books. Pp. 32. (Brooklyn, N.Y.: Chemical Publishing Co., Inc., 1945.)

Recent Purchases of Rare Books. (Catalogue No. 70.) Pp. 28. (Caerleon: Ifan Kyrle Fletcher, 1945.)