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CONTENTS

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SCIENTIFIC AND INDUSTRIAL RESEARCH IN GREAT BRITAIN

THE uniformity with which recent reports on scientific and industrial research have insisted that provision for scientific research in Britain was dangerously small before the outbreak of the present War has been taken in some quarters as a disparagement of British achievements. Only the most desultory reading of the reports in question could afford any support for that contention; on the contrary, there is general agreement as to the ability of scientific men in Great Britain and the merits of their achievement, as emphatically as there is agreement that the *per capita* appropriation in Great Britain, both for industrial and for public research, has been far below that in the United States of America and the U.S.S.R. It was a disappointing feature of the report of the Larke Committee on Industry and Research that it provided such meagre information under this head, but there can be no doubt that, had such information been incorporated in that report, it would have corroborated the evidence submitted by the Parliamentary and Scientific Committee.

In a particular field this is well illustrated by the report on methods of building in the United States recently issued by the Ministry of Works. This report of a mission appointed by the Minister of Works in July 1943 shows that the building industry in the United States is considerably ahead of that in Great Britain, not so much in the quality or organization of its research as in the scale on which it is prosecuted, the use made of scientific personnel in the industry and the effectiveness with which the results of research are disseminated. There is no doubt as to the appreciation in the United States of the results of British research and of some features of its organization, such as the Building Research Station. None the less, the main burden of this report is similar to that of all the more important recent general reports: more generous endowment and vigorous prosecution of research, the wider employment of scientific personnel at all stages in industry, and more effective means to secure that the results of research are made known in ways that facilitate their utilization in industry. A further special illustration is to be found in Dr. F. King's recent paper on "Petroleum Refining—A Chemical Industry", read on February 4 before the Society of Chemical Industry, when he powerfully urged the importance of expanding the petroleum refining industry in Great Britain by an adequate research and development policy, so as to provide the basic raw materials for a new chemical industry in the manufacture of solvents, plastics and fibres.

This neglect of new discovery was one of the main reasons for the relative decline in British technical efficiency in the inter-war period, and there is little, if any, dissent from the view that it is essential to remedy this position so that the country may be able to hold its own after the War in the general technical progress. There is now general agree-

ment as to the necessity for a marked expansion in the scope of technical and natural scientific research at the universities and other public institutions, as well as in the facilities for training scientific personnel for such work and for industrial research, and probably also that such expansion should be achieved by a suitable increase of the Parliamentary Votes for that purpose; but there is as yet some uncertainty as to how best research should be stimulated in industry itself.

That is one reason behind the controversy at present proceeding as to the suitability of the patent law system of Great Britain under present conditions and the question of compulsory licensing. The question was raised broadly by Dr. P. Dunsheath in his Atkinson Memorial Lecture and, apart from the suggestion that the present system does not really encourage research and development, the discussion has been linked up, on one hand with the wider question of the control of industry by the State, and on the other with the question of the manner in which the State should encourage research by the remission of taxation. The way in which this question is related to that of obsolescence was well put in an article in *The Round Table*, and superficial discussion may easily tend to blame the patent law system or industry itself for shortcomings which are due primarily to an archaic taxation system, out of harmony with the facts and requirements of modern life. The question whether the State should support, without further regulation, research carried on by private firms, either directly by subsidies or tax remission or indirectly by placing at the disposal of industry the facilities of, or results obtained by, public research institutions, has been examined by Dr. T. Balogh in an article in the *Bulletin of the Institute of Statistics, Oxford*. This illustrates the theoretical character of some of the discussions of this subject from the economic point of view. It may be generally conceded that the State's duty in the encouragement of research and development is primarily to foster self-help, under fair conditions, and not in the main to do the job itself; to favour enterprise of the right kind; and to lend public aid where private effort is insufficient. That the imperative task of research is not to maintain particular industries in a particular state of employment or profits, but to increase the national income, even at the cost of very radical adjustments in the structure of industry and employment, and in the use which is made of the nation's total resources, is much more likely to be challenged from the scientific and technical side of industry.

Dr. Balogh follows Dr. C. G. Paterson in arguing that modern development has changed the whole technical and economic background of the patent law system of Great Britain, and that this has not been explicitly recognized either by a reorganization of scientific research or by patent law. He concludes tentatively against subsidies to private investment in plant of existing types without adequate safeguards. While research into new methods or products may be stimulated in this way, as the new and more efficient methods resulting lead to a potential increase in the national real income and in the international competitive capacity of the country, the danger remains that the effectiveness of the new discovery will be either sterilized or used for the purpose of undue monopoly gains. Measures must, he urges, be taken to safeguard the interests of the community and against retardation of progress.

Dr. Balogh has thus really established the case for reform of the principles of inland revenue, but he goes on to expound the view that, as matters stand in Britain, the State must assume the main burden of increased research, and in the main the expansion of research should be undertaken by the universities or other public institutions. He appears to have in mind particularly the establishment of technical institutions on the lines of the Massachusetts Institute of Technology or of the Continental high schools; but since he suggests that the results of such research should be available on a licence basis to industry, presumably he does not favour a policy of full publication. Stimulus to public and private research in conditions which exclude a misdirection and misuse of the results should, in Dr. Balogh's opinion, be one of the main tasks of reconstruction, but his suggestions are likely to bring him under heavy fire from both the industrial and the scientific sides if they are seriously pressed.

The report on scientific industrial research which has been issued by the London Chamber of Commerce* may well be open to a similar type of criticism, at least as regards its chief new proposal for a central research board, both on the grounds of the practicability of finding the type of personnel necessary, and on the desirability or feasibility of the kind of direct control suggested. Much of the report, it is true, is not new. Reiterating that while the inventive genius and scientific knowledge of Great Britain are second to none, financial policy has put us behind others in the adequate provision of equipment for research, facilities for scientific and technical instruction, and such rewards to successful men of science as would ensure a sufficient supply of men of the first quality, the London Chamber of Commerce concludes that there are three essentials to stimulate research into full and fruitful activity.

Of these three essentials, two are in line with the recommendations of earlier reports, namely, a far greater stream of money flowing into research, and a larger, better trained and better paid personnel. The third, and foremost, is new, namely, centralized and planned direction through a central research board. This proposal has something in common with Lord Samuel's subsequent suggestion at the annual luncheon of the Parliamentary and Scientific Committee that the Lord President of the Council should exercise the functions of Minister of Science in the Cabinet.

Lord Samuel's suggestion is admittedly vague and might not in fact amount to much more than Dr. Dunsheath's proposal for a central co-ordinating secretariat and information service. The London

* Report of the London Chamber of Commerce on Scientific Industrial Research. Pp. 16. (London: 69 Cannon Street, 1944.)

Chamber of Commerce bases its proposal on the view that the support which has been forthcoming both from industry and from the Government for the fundamental type of research carried out by the research associations in Great Britain is insufficient to ensure either in quality or quantity the necessary measure of success. An attempt is made in the report to distinguish between 'fundamental' research and 'pure' research, aimed at the increase of natural knowledge for the sake of increasing knowledge and not for any particular industrial objective. The latter type of research, which in practice is hard to differentiate from long-range research on major technical problems, is regarded as an enterprise which should be financed by the nation, and should be carried on in the universities, though the desirability of close relations between industry and the universities in fundamental research, whether prosecuted in industry or at the universities, is recognized and welcomed.

The main purpose of the London Chamber of Commerce in urging the creation of a central research board to act as a co-ordinating and directing body for all research organizations and to form a link between the Government and the research activities of the country at large is to strengthen the present cohesion of our structure of research. The Advisory Council of the Department of Scientific and Industrial Research is not constituted, nor would its present terms of reference enable it to act, in the way and for the purposes now envisaged. A central research board, for example, should have as a primary function the encouragement of private firms to make available to industry at large, through the board, those discoveries which they did not feel it necessary to retain for their exclusive use. The board should accordingly be empowered to make grants, free of income tax, to private firms for such discoveries as are surrendered to the board, and these payments would be designed to encourage firms to complete lines of investigation which they might otherwise abandon as too remote from the problems of their own industries.

A second function of the proposed central research board would be to ensure that adequate facilities are available in every research association for private work, under conditions which would create confidence, on behalf of small firms. It is also proposed that the board should have the right to intervene and require research associations, in consideration of the public funds placed at their disposal, to undertake fundamental research in directions which it judges to be in the national interest, and to require greater activity on the part of those research associations which, in the opinion of the board, are proving unequal to their responsibilities. It should be the further duty of the board to consider the effect upon trade and industry as a whole of discoveries of a fundamental nature, and to direct the use of those discoveries so that they may be of the maximum advantage to the nation.

The duties of the board would not end here. With regard to the fundamental research carried on in the universities, the board would have the function of ensuring that the results of such research would be applied in the shortest possible time. Scientific men in particular may well begin to wonder what manner of men they may be who will constitute the board, and they will be glad to learn that a highly qualified secretariat is recommended to assist in handling the complex problems involved. Again, it is suggested that the Board of Trade or the Department of Overseas Trade should place before the central research board any facts bearing on the loss of markets by British products, at home or abroad, due to poor quality or high price, and the board should take up the matter with the research associations and with individual firms.

Within its charter a central research board should have the same freedom of action as the British Broadcasting Corporation, under the ægis of, and presumably responsible to, the Lord President of the Council. Five industrialists, with practical experience, four men of science, and three representatives of labour, with a whole-time highly salaried chairman, and the full-time, expert secretariat already mentioned, are suggested as constituting such a board. Alternatively, the Council of the Department of Scientific and Industrial Research might be reconstituted on similar lines and its terms of reference widened to permit it to discharge the functions proposed. The present functions of the Advisory Council for Scientific and Industrial Research might then be discharged by a committee of the board. Finally, the question is raised for consideration whether a central research board should delegate its functions concerned with the universities to the University Grants Committee, or to a separate body concerned with research only, leaving the University Grants Committee to continue to function as at present with regard to all funds not specifically earmarked for research.

With regard to finance, the report considers that the universities should maintain a far larger staff than at present of graduates and of skilled laboratory technicians, and recommends a substantial increase in the number of research fellowships at the universities. The whole of the present annual Treasury grant to the universities would be quite inadequate to enable them to carry on the research which the London Chamber of Commerce regards as essential; indeed it strongly supports the Parliamentary and Scientific Committee in its recommendation that a sum of £10,000,000 should be spent over the first five post-war years in equipping and enlarging the university laboratories, apart from carrying out the expansion of the technical and art colleges on a programme estimated before the War to cost £12,000,000. The report urges, however, that all applications for research grants should come to the proposed central research board and be made by it to the Government, and that similarly all grants made by the Government should pass through its hands.

With regard to the research associations, the report advocates a compulsory levy, where necessary, on each industry for which a research association is thought appropriate. Again, the report is in agreement with the view of the Federation of British

Industries that all expenditure on research and development should be chargeable against revenue, either immediately or over the commercial life of any asset created. It also urges that the cost of pilot plant, as well as of laboratory buildings and equipment, should be chargeable against revenue.

The London Chamber of Commerce is impressed with the need for attracting to a scientific career a larger percentage than at present of men with first-class brains, and urges the up-grading of salaries offered to scientific men in industry, the research associations and the universities. Reference is also made to the importance of technical education and of much more generous endowment of the technical colleges; while finally, the importance of publicity is stressed. Individual undertakings must be made more research conscious, including employers, shareholders and workers alike. The report expresses the belief that there are resources of inventiveness and ingenuity among the people of Great Britain generally which skilful propaganda could assist in tapping.

In the main, the London Chamber of Commerce has merely restated the arguments for the expansion of our research effort on lines urged by the Federation of British Industries, the Parliamentary and Scientific Committee, and other bodies and individuals, with the specific exception of its proposal for a central research board. On this proposal two main comments may be made: first, the organization indicated may prove too rigid and demand too much of the individuals constituting the board, which scarcely seems to fit the machinery of government; and secondly, there is no apparent provision for seeing that research is prosecuted in the biological and social sciences in comparison with the physical sciences to the extent required to maintain a better balance in the advancing front of science. That there is need of some further measure of co-ordination of our research effort is scarcely questioned; but the manner in which that can best be planned or controlled without detriment to the internal discipline or freedom of science is a matter for serious discussion.

Here the report does well to raise the question of the adequacy of the University Grants Committee in regard to research purposes, as was done in the report of the Parliamentary and Scientific Committee. The question is also discussed in a recent memorandum on "The Development of Science" issued by the Association of Scientific Workers, which suggests that to assure adequate financial resources for fundamental scientific research and the wise use of those increased resources, a university council, reporting, for example, to the Lord President of the Council, like the Scientific Advisory Committee, should be formed to extend the functions of the University Grants Committee. It should be competent to discuss in detail all questions of university policy, and, without impairing the independence of the individual universities, it would provide a democratic machinery by which the universities as a whole could take the guidance of their future into their own hands, and the Association suggests that a body of the type indicated in the memorandum should achieve a greatly increased measure of self-government of university science by university men of science.

By and large, the stimulation and endowment of fundamental research on an adequate scale is the first and main problem. Opinion may well be reserved as to how far, or how soon, the creation of a university council of the type suggested is likely to proceed without some external stimulus or some far-reaching university reforms; and if university co-operation has not been particularly marked in the past, the capacity of scientific workers to co-operate even within a limited field of science has not been so successful that the prospect of increased self-government will make any pronounced appeal to them or to the community. The first step may well have to be taken by the Government, following the lead given by some such body as the Parliamentary and Scientific Committee. The adequate endowment and prosecution of industrial research should follow from such steps, once fundamental research has been adequately planned and endowed, and given right relations between the State and industry. The discussions which are already proceeding as to the mechanism of State control, the relations between enterprise and planning, between taxation policy and the encouragement of development and research, and between patent law and industrial research are all to be welcomed as contributing to this end. If such discussions can be kept clear of faction or prejudice, and pressed home to lay bare the fundamental issues, they can do much to indicate the right lines on which the organization of research should proceed in Great Britain. They will suggest conditions likely to stimulate creative thought and invention, and also ensure, not merely that the maximum social use is made of advancing scientific knowledge, but also that adequate effort is concentrated in those fields where social needs, instead of financial or other sectional interests, show it is likely to yield the maximum advantage to the community.

WORK OF IMPERIAL CHEMICAL INDUSTRIES, LTD.

THE record of British industrial achievement during the War remains to be written. A veil of secrecy conceals most of it, and it is only here and there and at rare intervals that a small part of the veil is lifted. Such an occasion was Lord McGowan's speech at the Glasgow Chamber of Commerce recently, when, for the first time during the War, he recorded some of the work of Imperial Chemical Industries, Ltd., emphasizing the fact that it was only a small part of the company's activities of which he could speak. The system of private enterprise on which he said Britain's national greatness had so largely been built had been criticized and misrepresented, and it was the duty of British industry to answer vague innuendo with definite fact and record of real achievement. Especially was it a duty owed to the workers and management class who, so far as

his own companies were concerned, had worked faithfully through more than four years of strain and stress, to deliver the goods both to the fighters in the field and to the people at home.

Though designedly limited in scope, the record was impressive, an outstanding feature being the company's pioneer work in the production of oil from coal, a triumph of courage, foresight, research and engineering skill, none of which, said Lord McGowan, would have been forthcoming in adequate degree unless private enterprise had been free to run the risks involved. No State department could have taken such a decision, involving expenditure of millions sterling; and if it had, Parliament would have vetoed the project. As a matter of fact, the decision to erect a plant at a cost of £3,000,000 was carried in the face of strong opposition in Parliament and in the Press. Lord McGowan said:

"I.C.I. were then accused of gambling with shareholders' money and wasting money and energy by making something which could be brought from overseas much more cheaply. What has happened? Before the War that plant gave much new employment at a time when unemployment was rife. It used British coal to make motor spirit instead of this being imported. Its operation afforded technical experience which was very valuable when applied to other products. From the national aspect it was vital."

All this and much else has been more than confirmed during the War. I.C.I. and companies like it have, moreover, formed the only source from which men with experience of large-scale operations could be drawn as key men to operate the vast ministries established for war purposes. In numerous other fields besides the manufacture of oil from coal, I.C.I. has done invaluable work, most of which is based mainly on peace-time research carried out by the company.

Lord McGowan said that he had been astonished by the amount of research and invention since 1939, but most of the results must remain secret for obvious reasons. There is at all events conclusive evidence that the British race has not lost its spirit of inventiveness, and all enemy devices have been more than matched on sea or land or in the air. His company had many inventions which would prove invaluable in peace as in war, such, for example, as synthetic fibres and new kinds of plastics, to say nothing of the many fruits of agricultural research. They were already planning a vast post-war programme which would, among other things, contribute substantially to the provision of full employment envisaged by the Government, and involve an expenditure of many millions of pounds over the next five years for plant replacement, extensions and new factories, including many required for new products. Lord McGowan emphasized that private enterprise is quite capable of showing that spirit of adventure and courage on which the British Empire has been built. His own company, he said, is not peculiar in this: throughout the whole realm of British industry the same spirit reigns, and only asks for freedom and scope to exercise itself.

The student of political and social science should have much on which to ponder here, though it is difficult in such a case to disentangle political bias from scientific objectivity. The address has been criticized as a record that does not necessarily support the doctrine of private enterprise and as not prese ting a correct picture of the financial support given, and risks incurred, by the State, for example, in the oil-from-coal enterprise. As a scientific journal we cannot take sides on the political issue; nevertheless, the extent to which scientific research on a large scale has justified itself in this particular example of private enterprise is very impressive. Further, it will be agreed that there appears to be in British industry abundant evidence that the love of adventure and enterprise for its own sake is often as powerful a motive as profit-gaining. It is sometimes complained that we can have no science of society or of politics in the strict sense because we cannot have the same exactness of controlled experiment as in chemistry and physics. One is a little weary of this very unhelpful comparison. At all events the student of political science, if we admit the validity of such, can approach these problems in a scientific spirit, collect such experimental data as are available—frequently more abundant than is commonly supposed—and weigh and evaluate motives and causes with an open mind unclouded by political prejudice.

APPLIED CHEMISTRY

Thorpe's Dictionary of Applied Chemistry

By the late Prof. Jocelyn Field Thorpe and Dr. M. A. Whiteley. Fourth edition, revised and enlarged.
Vol. 5: Feh–Glass. Pp. xxiv+610. 70*s*. net.
An Abridged Index to Volumes 1–5 of the New edition of Thorpe's Dictionary of Applied Chemistry. Pp. 20. 3*s*. net.
Vol. 6: Glau.–Inv.; with an Index to Vols. 1–6, by Dr. J. N. Goldsmith. Pp. xii+611. 80*s*. net.
(London, New York and Toronto: Longmans, Green and Co., Ltd., 1941, 1943.)

THE troubles of producing such a work as this are manifold even in peace-time. When to war conditions we have to add the death of one of the editors, Sir Jocelyn Thorpe, it is really surprising to see that the standard of contributions in these volumes reaches such a high level. Dr. M. A. Whiteley in a foreword refers to the abridged index to Volumes 1–5 published at the same time as Volume 5, and indicates by the phrase "had the Dictionary been published as a complete work" that perhaps no more volumes might appear during the War. Since then, an editorial board has been formed comprising Prof. I. M. Heilbron, Dr. H. J. Emeléus, Prof. H. W. Melville and Prof. A. R. Todd. Dr. Whiteley continues as editor and Dr. A. J. E. Welch as assistant editor. It is hoped to complete the current edition with eight further volumes, published at yearly intervals, and Volume 6 is the first of the new series under the editorial board.

It might be thought that the board of editors are better constituted to produce a dictionary of pure chemistry than one dealing with the applied side. This idea is rather emphasized by the articles on heterogeneous reactions and homogeneous catalysis

which are mentioned on the fly-leaf to Volume 6 as being innovations in the new series to give greater emphasis to physical chemistry. These articles are definitely more suitable for a text-book on pure physical chemistry. An applied chemist will find that a reasonable appreciation of the fundamentals of aerodynamics together with diffusion theory will be far more helpful in actual practice than the theoretical material given under the heading of heterogeneous reactions. Hydrogen ion concentration has very many and varied applications in industry, and books have been written on the subject. Here, however, it is dismissed in a short notice on how it can be measured.

This lack of attention to the word "Applied" on the title-page is shown in other ways. Practically no attention is given to the economic side of chemical manufacture. As an example, the article on glucinium might be taken. If anyone wished to manufacture beryllium at the present moment, he would be ill advised to think that the information given him in Volume 6 of this dictionary is sufficient for his purpose.

It is invariably advisable when adopting an applied process to make a thorough search of the patent literature. It would therefore be more comparable with commercial conditions if the patent references outnumbered the others. Actually, the reverse is the case.

There would seem to be a requirement for a simple statement to act as a guiding principle in applied chemistry. The physicist has, for example, Fermat's principle, which states that, "The path of a ray of light from point to point is always such that the time taken by the light to traverse it is a minimum". Similarly, in the realm of mathematics, we have the names of Maupertuis and Hamilton and the Principle of Least Action. In applied chemistry the principle could be stated as, "The production of one chemical compound from another will follow such intermediate stages as result in the time taken to make a unit quantity of the product being reduced to a minimum".

This statement might sound like a platitude, but experience goes to show that its importance is only very slightly understood even in circles where the level of intelligence on other matters is very high. The phrase 'time taken' requires perhaps further definition. The time taken in manufacturing the plant for carrying out the reaction, the time taken in producing the energy supplied to the reaction in the form of electricity, steam, etc., and the time which is covered by the various items of chemical works costing are all best expressed by a monetary value which allows the time factor to be expressed in comparable units. The expression 'man-hours' is possibly the more justifiable unit but is not necessarily so easy to compute.

The outstanding feature of Volume 5 is the collection of articles on fibres. They include "Cotton" by Dr. A. J. Turner, "Rayon" by J. M. Preston, "Finishing Textile Fabrics" by E. Clayton, "Animal Wool" by Dr. J. B. Speakman, "Vegetable Fibres" by E. L. Hill, and "Silk" by Dr. C. S. Whewell. These articles also raise a point of interest to the general reader seeking information. Would it not have been better to have preceded this collection of articles by a short introduction on the industry as a whole and the meaning of the numerous technical terms used in it? Nearly all the ancient industries such as textiles, leather, brewing, etc., have a wealth of technical words which do not appear in the usual dictionaries and which therefore need defining for the non-expert. Thus under "wool", we read about wool quality as estimated by the grower and referred to as "60's–64's Cape Merino wool", but how does the grower estimate the wool, and why does he use these numbers? What is meant by "denier" and "counts"? How does the length and thickness of the fibre affect the subsequent processing? Perhaps a Baer diagram might help the novice. What are the principles which affect the wearing properties of the textiles? Why are some cold and some warm to wear? Why do some crease and some drape? It might be argued that these are not chemical problems, but they are at least the qualities which ultimately influence the direction of the policy of future development of all chemically produced fibres. Attention should also be directed to an extensive article on glass by Dr. H. Moore, others on fuel by Dr. G. W. Himus, and on coal and water gas by Dr. H. Hollings and E. G. Stewart and W. A. Voss respectively. Under fermentation, the late Sir Arthur Harden writes on the alcoholic side, Dr. J. H. Birkinshaw on mould and Dr. M. Stephenson on bacterial. Other articles worthy of mention are on fertilizers, by Dr. B. Dyer, formaldehyde, by Dr. H. M. Stanley, and fluorine, by Dr. H. J. Emeléus.

Volume 6 also contains a number of interesting articles, especially those by Dr. E. H. Rodd on indigo dyestuffs, Drs. E. Lewkowitsch and H. E. Cox on glycerine, H. S. Coles and Dr. P. H. Sykes on hydrogenation, Sir T. K. Rose on gold, W. H. Hoffert on gum inhibitors, Dr. D. Burton on glue, Prof. G. A. R. Kon on hormones, Dr. C. A. Mitchell on ink, Drs. J. A. Kitchener and M. Carlton on hydrogen peroxide, Dr. R. Holyroyd on coal hydrogenation, and Dr. A. J. E. Welch on helium. The article on grassland by Dr. J. A. Hanley might well have been expanded in view of the importance of its proper utilization and of the drying of grass for storage in relation to the agricultural economy and self-sufficiency of the nation. Similar comments might be made of A. G. Pollard's articles on gooseberry, grape, grapefruit, honey and huckleberry, even after allowing for the nostalgic feelings they engender after these years of war.

M. B. DONALD.

NEW LIGHT ON TELEPATHIC PHENOMENA

Experiments in Precognitive Telepathy

By S. G. Soal and K. M. Goldney. (*Proceedings of the Society for Psychical Research*. Part 162, December 1943.)

THE experiments here described, which were conducted by the authors during about two and a quarter years, are some of the most interesting and suggestive hitherto recorded. For a number of years the Society for Psychical Research has been supporting a number of experiments in the field of what has been called 'extra-sensory perception', and gradually a mass of evidence has been accumulated which is throwing a good deal of light upon phenomena which have been perhaps some of the most hotly disputed in the whole field of recent work in psychical research.

Generally speaking, the essential core of the experiments consists in the examination of the scores

attained by 'guessing' symbols or pictures in sets of five cards for convenience of statistical analysis. In a number of these tests the subject tries to guess the symbol or picture on a card that is being looked at by an experimenter seated in an adjoining room, his score being later examined to ascertain if he had attained more correct hits than the theory of probability would predict.

Now since the experiments were first started, there has been a very large volume of criticism designed to expose alleged sources of error in the actual work and faulty employment of statistical theory in evaluating the results. In the present series it would seem, judging from the record presented, that such criticisms would be beside the point. Rarely has such scrupulous care been exercised to avoid all possible source of error, and the statistical methods employed were so simple that attempts to discredit them would probably be a waste of time. Moreover, some of the results obtained excluded by their very nature many of the commonly alleged sources of error, and at the same time revealed some surprising effects which had been suspected and later proved to have occurred in previous experiments.

In the past, the prevailing tendency was to study the success obtained by the percipient in guessing the symbol which was being contemporaneously looked at by the agent. In a number of such cases it seemed that certain subjects were successful in scoring over a considerable period many more correct hits than the theory of probability would lead us to expect. But at the same time it appeared that when the records were carefully examined, the 'successes' were not always of the 'now or never' type, but a kind of displacement occurred both backwards and forwards; so that it seemed that at times the card images were becoming known to the percipient before the agent himself was consciously aware of them.

In the present series of tests this phenomenon is further examined, since the subject with whom the work was done appeared to find it easier to score hits, not on the card that was being looked at by the agent, but on the cards which immediately precede or follow it in sequence. The normal rate of guessing varied between limits of 50 sec. and 80 sec. for twenty-five calls, but when this rate was speeded up the cognition of the card in advance of that being looked at by the agent was replaced by a cognition of the card *two ahead* of the one being concentrated upon. This very remarkable effect is in itself sufficiently surprising, while at the same time it disposes of much of the criticism which might have been valid in badly conducted experiments where scores were solely confined to the card being looked at by the agent.

The theory that these effects are due to chance coincidence is considered by the authors of the reports to be completely untenable. For example, to take the one-ahead or precognitive (+1) guessing only, the results are highly significant, for the excess is equivalent to 13·6 standard deviations with odds of more than 10^{35} to 1 against chance.

In discussing the interpretation of these phenomena the authors very wisely make no attempt to deal in any way fully with their psychological and philosophical implications. It is clear, however, that if the results be upheld, light may be thrown not only upon our ideas of time but also of the nature of memory; and moreover, it seems that the earlier and naïve ideas of 'thought-transmission' may have to be abandoned. In any event we have here another step forward in the design of experiments of this kind, and the authors are to be congratulated upon their arduous labour, their scrupulous care in conducting and recording their work and their wisdom in not attempting facile explanations to describe the nature of phenomena the meaning and interpretation of which are likely to elude us for a long time to come.

E. J. DINGWALL.

EARLY SPANISH POSSESSIONS OF THE NEW WORLD AND FAR EAST

Compendium and Description of the West Indies By Antonio Vázquez de Espinosa. Translated by Charles Upson Clark. (Smithsonian Miscellaneous Collections, Volume 102, Pub. 3646.) Pp. xii+862. (Washington: Smithsonian Institution, 1942.)

IF one has a complaint against the editor and the producers of this important work, it is that the title is seriously misleading. Mr. C. U. Clark has provided a most informative introduction, and there is a very full index. The main body of the text, running to nearly 800 pages, is a translation of a manuscript in the Vatican. The original, written by Antonio Vázquez de Espinosa, for the Council of the Indies, was called a description of the Indies and dealt with all the Spanish territory in the New World as well as that in the Far East. We have here, therefore, a detailed account of a large part of North, Central and South America, the Philippines and Moluccas as well as what are now known as the West Indies, as it was about the year 1620.

It is impossible in a short review to do more than allude to the many interesting features of this work, only a small part of which has been previously published. There are valuable details of discovery, with a new account of the notorious Aguirre. Natural phenomena, like earthquakes and floods, trees, cultivated plants, mineral resources, the customs of the native population, and full details of the Spanish colonial administration fill the pages of Espinosa's work. He was a Carmelite missionary and was therefore naturally interested in church matters: and education figures largely. But there is no undue praise of what the Spaniards had accomplished. His descriptions of depopulation, "a general curse in the Indies", neither conceal the facts nor avoid the inevitable consequences, though not all were attributed to misconduct or bad administration. On the other side of the account are the constructive works of the Europeans. The great city of Lima, for example, known as The Kings, founded in 1533, is minutely described, with its irrigation works, its water supply, its rectangular blocks of buildings separated by wide streets, its four plazas, its government buildings, churches, ecclesiastical dignitaries, convents, nunneries, hospitals, university, colleges, and, two leagues away, across an arid plain, the port of Callao with its garrison, shops, stores, mills, and a good, safe harbour "free from shipworms", for "the sea water is so cold here that they chill beverages in it".

Such descriptions, with immense detail of great interest, are frequent. In short, this work will provide historians and naturalists with invaluable information on all parts of the old Spanish colonial world.

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ORIGIN AND ACTION OF DRUGS

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DETAILED study of the action of drugs constitutes pharmacology, but it is doubtful whether study of their origin has reached the level of a scientific subject, though it is described by materia medica or pharmacognosy, and incidentally by biology and chemistry. It is the object of the present survey of therapeutically active substances to show that both their actions and, of naturally occurring drugs, their origins, have additional significance when considered together as aspects of comparative biochemistry.

Attempts to find theoretical connexions between the sources and the properties of drugs have been made many times during the past five hundred years. The subject greatly interested the early naturalists and carried to their work the practical stimulus of possible application in medicine. In pre-scientific times, writers of the early herbals (for example, the German Herbarius[1] of 1485) saw in the fact that mineral and plant products affected animals an indication of a common divine origin of all Nature and expressed the mode of interaction through the four elements; but their outlook had not the objectivity necessary to a scientific study. Among working hypotheses it appears to have supported mainly astrological beliefs and the doctrine of signatures[1,2] which were of value to medicine only in so far as they led to investigation of the virtues of plants.

Certain more objective connexions between the medicinal properties of some plants and their own structural characters have been incorporated in various botanical classifications, and many are still recognized as valid. They are of more significance to our present study, though they offer only a partial solution to it. When medical aspects of botany constituted a major part of the subject, classification of plants was frequently on the basis of their medicinal properties. Other affinities between plants were, however, obvious, and some of these—the petal arrangements of crucifers, or the type of inflorescence of the Compositæ—formed the beginning of natural classifications. There was a significant intermediate period when, in the same volume, some plants were grouped according to structure and others according to their use—a period when botany was beginning to develop as a subject in itself, but was maintaining a close relation to medicine. As the natural classification of plants evolved, the part played by medicinal virtues as differentiating characters declined, though even in Linnæus's rigid system it was evident that a certain connexion existed between morphological and medicinal properties. This was, understandably, emphasized by Linnæus and his protagonists[2,3,4] as being a valuable outcome of the study of taxonomy. The later, more fully developed, natural classifications could claim even closer connexions with the properties of plants, and these were expressed by A. L. de Jussieu and especially by A. P. de Candolle[4]. De Candolle was, indeed, able to use therapeutic properties as differentiating characters in a few debated instances in taxonomy. It is interesting to us now to note that this aspect of comparative biochemistry was contemporary in origin with the present biological classifications.

As biology and chemistry grew as subjects in themselves, such connexions tended to be forgotten and it was considered surprising that a morphologically based classification should receive support from the comparative biochemist[5]. This was especially so at the end of the last century, when many botanists and chemists referred to alkaloids as waste products: they were neither fish, flesh nor fowl to the fat, carbohydrate and protein biochemistry of the day. Since then, ecological studies have tempered such opinions; and alkaloids, glycosides and other substances of pharmacological action have been more generally credited with defensive or offensive powers of value to the organisms producing them. This aspect had indeed never been entirely lost, but higher plants and animals are now realized as being far from alone in producing materials deterrent to the growth or predation of other organisms. Recent studies of mutually antagonistic relations between micro-organisms have added further examples both to this very general phenomenon and to practical therapeutics. But what is the basis for this mutual interaction? When such processes exist, they may be of value to the organisms producing the inhibitory material, but not all such interactions can be regarded in this way. Often the materials are produced only under peculiar conditions of growth, or are highly active against organisms with which they do not normally appear to come into contact. That this is so may indicate only our ignorance of details of their past or normal existence, but many minor interactions take place between organisms not usually credited as antagonistic; and such interactions can be in the direction of either antibiosis or symbiosis according to environmental conditions. Are we then to regard the interacting materials as chance metabolic products—an elaboration of the suggestion of alkaloids being waste products[6]? If so, why should the interaction of product and organism be so universal? There are general similarities between fundamental processes in most living organisms; but what basis do these give for expecting antagonistic relationships?

Let us approach the problem by returning to an earlier point. The possible protective value of a compound to an organism provides a basis for natural selection of the organism producing it, but not for the origin of the compound. Sometimes, inhibitory compounds bear resemblances to other naturally occurring compounds of known biochemical importance; at other times, a given compound itself has either stimulating or inhibiting properties under different circumstances—in different organisms, or in different concentrations[7]. It is upon the basis of such relationships to metabolic processes, both in the organism of their origin and in that upon which they act, that the present account will consider the origin and action of biologically active substances, including those which have found application as drugs.

A General Basis for Pharmacological Action

Drugs are, or owe their activity to, chemical substances; the preparation of the virtues of plants in defined form, amenable to exact study, was a major result of early applications of chemical methods to pharmacology. The late nineteenth century application of physics and chemistry to the study of the action of drugs was not so secure; the peculiar characters of drugs are exhibited primarily towards living organisms, and the correlations suspected between these characters and the physical and

chemical properties of the agents exist but are relatively limited in extent. Their discovery seemed an immense progress, and its contribution to the impression that drug action was one of material interaction with living cells was an important one; but such correlations left untouched the major problem of how a minute quantity of a *substance* could affect a living *process*. The solution of this problem required a further analysis of living processes. Thus, early workers in chemotherapy and pharmacology attempted to consider the actions of drugs in terms of their affecting the known vital processes of nutrition and respiration[8]. This left the mechanism of the required connexion entirely hypothetical; a closer analysis was required to find the systems, peculiar to living organisms, which were affected by drugs and were of types as varied as the receptors of pharmacology would suggest.

Such analysis has proceeded indirectly and is connected with our present subject through the following steps. (*a*) The classical drugs represent only one type of chemical substance capable of specific interaction with living systems. It is a major characteristic of other reactions between substances and processes in living organisms that they commonly occur through, or under the control of, enzyme systems. In intermediary metabolism, the necessity for magnesium salts in fermentations, for flavine nucleotides in amino-acid oxidation, for iron-porphyrin compounds in reactions with hydrogen peroxide, have been found due to these substances forming parts of specific enzyme systems. (*b*) Following upon the recognition of the importance of enzymes in living processes, certain pharmacological agents were demonstrated to owe their specific effects to actions upon enzyme systems (see below). (*c*) Many substances of critical importance in intermediary metabolism are of widespread natural occurrence and can function in organisms other than those in which they originated; and both in the organism of their origin and in those in which they secondarily act, they are connected with enzyme systems. This is true not only of the general categories of carbohydrate, fat and protein but also of substances more akin to classical drugs in their potency and specificity of action. Thus aneurin functions in pyruvate metabolism both in the yeasts and bacteria which synthesize it and in the animals to which it is a vitamin; similar details can be given of nicotinamide and riboflavine derivatives.

The following paragraphs present evidence for a basically similar, though more complex, state of affairs with respect to pharmacological agents in general. The first two points relate to the natural occurrence of biologically active substances, and the latter two to the behaviour of such substances in biochemical systems.

(1) *The quantities of such substances produced by different organisms, or occurring in different parts of them, are very variable.* It is not surprising, or important in the present connexion, that this should be true of carbohydrate or fat; the significance arises in the variable occurrence of substances of more specific action. This is especially well documented with respect to vitamins. Compilations[9] of the vitamin contents of foodstuffs (mainly organs or tissues of higher plants and animals) show variations of many hundredfold and frequently to 10,000-fold in their contents of vitamins A, B_1, B_2, C and of substances of vitamin D activity. This assessing discounts materials described as possessing only 'traces' or 'none' of the vitamins, and does not include values for prepared materials such as bread or oils; the range is thus minimal. Relatively few micro-organisms have been examined in this way, but considerable variations in vitamin production between only six species of bacteria are reported by Williams[10]. Yeast strains can vary considerably in their production of such substances[11].

(2) *In different species, a given function may be performed by related, and not identical, substances or processes.* A classical example is the different forms of excretion of nitrogen in mammals, birds and teleosts, when physiological reasons for the differences can be suggested[5]. They are necessarily associated with differences in the enzymic make-up of the tissues of the different animals, notably with variations in the occurrence of arginase. Again, creatine phosphate in the muscles of vertebrates is replaced by arginine phosphate in the invertebrates. The varying pyrrole respiratory pigments of vertebrates, molluscs, and annelids afford further examples. Among processes, interesting differences exist in the enzymes oxidizing glutamic acid in animal tissues and in yeast, which require respectively coenzymes I and II[12]. Detoxication of benzoic acid can be by glycine or ornithine, and of phenylacetic acid by glycine or glutamine, in different—often closely related—species[13].

(3) *A substance normally essential to a particular process may, by being present in excess or under different conditions, inhibit the process.* Examples of the inhibition of enzyme reactions by excess substrate or products are common[14], and have been given as a basis for many of the following processes of whole organisms. In microbiology: 10^{-7} *M* nicotinic acid is necessary for growth of dysentery bacilli, but higher concentrations inhibit it[15]; small quantities of *p*-aminobenzoic acid, preformed or synthesized by the organism concerned, appear necessary to many micro-organisms which are inhibited by higher concentrations[16]. A given amino-acid (threonine, valine, leucine) may promote or inhibit growth of *Bact. anthracis* or a Neurospora strain according to the nature and quantities of other amino-acids present at the same time[17]; in these cases the balance between stimulation and inhibition is extremely delicate, and small structural changes or concentration differences have very large effects. The phenomenon is also found in growth of *Proteus morgani*[18]. Rats are injured by diets of high tyrosine content[19], though the substance is a constituent of their proteins. Ill effects following excessive vitamin intake may also be quoted; hypervitaminosis-D (and probably -A) have been reported, the latter instance[20] being of especial interest as it was observed in man and rats following ingestion of natural foodstuffs and not of a concentrate.

(4) *The processes associated with a given substance may be inhibited also by substances structurally related to it.* Again, this is well-documented in enzyme reactions[14], succinic dehydrogenation being inhibited by malonate; dehydrogenation of lactate, by other α-hydroxyacids; hydrolysis of fats, by alcohols and phenols, and of peptides, by other amino-acids. Transamination between keto-acids and amino-acids is inhibited by certain fatty acids[21]. The phenomenon also occurs in growth of micro-organisms[7,8,22], when the growth-promoting effect of nicotinic acid may be prevented by pyridine-3-sulphonic acid; of aliphatic aminocarboxylic acids, by aminosulphonic acids; and of pantothenate, by pantoyltaurine and by a number of other analogues. Inhibition by indole-

acrylate is annulled by tryptophan; that by ethionine, by methionine. Such effects may also be reproduced in higher organisms[23] by analogues of vitamin B_1, of vitamin C, and of the anti-hæmorrhagic K vitamins. Actions in many of the more complex systems have again been referred to enzymology.

Biological Interactions in Relation to Pharmacology

The apposition of paragraphs (1) and (2) with (3) and (4) leads to the following conclusion: that known properties of enzyme systems, and the observed variations in the occurrence and structures of metabolically functioning substances of living organisms, provide a basis for processes in one organism being affected by products from another. This does not exclude other bases for such actions; but is sufficient to suggest pharmacological action to be inevitable. If, however, the above factors were the only ones to be considered, such action would not be expect d to be associated with many characters which are, in fact, observed. Detoxication mechanisms in animals and the association of substances of pharmacological effects with special structures (in nettles or snakes) emphasize that biological interactions have not been taken into account. Pharmacology is concerned with aspects of the behaviour of animals which have evolved while dependent upon other organisms for food, and of plants to some extent dependent upon animals for fertilization and dissemination. All can persist only in so far as they maintain their own characters in spite of, or through, their relations to other organisms and to their environment in general. The connexions, discussed earlier, between the position of some organisms in natural classification and in content of pharmacologically active agents presumably persist because such agents are of value to the organisms producing them.

Two types of behaviour can be recognized as developed from the simple, inevitable type of interaction to be expected from paragraphs (1) to (4). First, both animals and plants elaborate agents which are much more potent in their damaging or obnoxious properties than are, for example, vitamins. Secondly, animals react to a large number of deleterious substances by not assimilating or by rapidly excreting them; and by changing them to non-toxic substances by combination or breakdown. Many of the detrimental interactions with potential drugs are thus normally avoided by the various means by which organisms are found to maintain their independence, but the procedures of isolation and administration of drugs are ones which would be expected to break down such independence. A particular tissue, organ, or substance is commonly selected and put to intimate contact with a wound, the eye, alimentary tract, or bloodstream of the animal receiving the drug. Micro-organisms, during their growth in common media, are in particularly intimate contact and are found to exhibit mutual interaction to a high degree, both in the sense of symbiosis (for example, through the production by one organism of substances which must be obtained pre-formed by the other) and antibiosis (for example, in the production of gramicidin, penicillin, or iodinin, which inhibit the growth of many other organisms).

A General Classification of Therapeutic Action

The present account has suggested a common basis for the actions of a wide range of substances in pharmacology and related sciences. This is amplified in the table opposite, which compares the activities of typical pharmacological and physiological agents such as eserine or phloridzin with acriflavine, microbial antibacterial agents, vitamins and hormones. The latter groups have an uncertain place in current textbooks of pharmacology, though some authors have welcomed them as filling gaps in the 'materials of animal origin' left by extrusion of less delectable items of the older materia medica. Biochemical localization of drug action is in many cases still a subject for debate and research, and the types of action given cannot be exhaustive. The following points call for special comment.

(1) It is not intended to suggest that simple enzymic processes necessarily provide the basis for all therapeutic actions; obviously—as is suggested by Section V of the accompanying table—the presence of enzymes in cells is conditioned by other processes which may or may not be enzymic; also, the term 'enzyme system' has been used advisedly to include series of linked and dependent or physically associated reactions which may represent types of organization more complex than those of the typical purified enzymes, but which can be studied by biochemical methods in tissues and cells. In such studies it is indeed especially necessary to consider the level at which interaction with the biological component takes place[24].

(2) Enzyme reactions can be affected by means other than the supply of coenzyme or interaction with metabolite analogues, which have been emphasized in the above account; though the view has been expressed that most specific pharmacological actions are through structural resemblance between the active agents and natural substrates[25]. Certain natural antibacterial agents act through chemical reactions with enzyme or substrate: notatin[26] and milk flavoprotein[27] by hydrogen peroxide formation; penicillic acid, possibly by reaction with amino-acids[28]. These represent further types of action which make the metabolic processes of different organisms incompatible.

(3) The table presents a classification according to the systems upon which the drugs act. The present account has emphasized that in the case of naturally occurring agents this is one side only of a more complex interaction, and that to characterize fully such a drug it would be necessary to consider its relationship to systems in the organism of its origin. Synthetic drugs exhibit no such dual relationship. This provides one reason for the present classification according to the system affected by the drug. A second reason is that, even among natural drugs, the occurrence of many can be considered to be more related to the system which they affect than to that in which they originate, in so far as their perpetuation as defence mechanisms is accepted. The two aspects may be illustrated by, on one hand, snake venoms, which would appear to owe their present existence in snakes to their effect upon higher animals; on the other hand, it is more doubtful whether this is the case with toxins of bacteria the normal habitat of which is soil, as with *Clostridium tetani*.

With respect to synthetic drugs, the large number of compounds empirically prepared before a successful drug is discovered is only too evident; it has been generally realized, and expressed in the receptor theories, that this process was one of finding molecules to fit somewhat elusive structures in living cells. Such is the basis for the practice of using as guides almost any compound of natural occurrence, of

pharmacological action, or with the evident powers of combining with cells which are shown by certain dyestuffs. Greater knowledge of functioning systems in organisms can be expected to provide increasingly more direct methods of preparing compounds of desired activity; but it must be emphasized that the cinchona tree, for example, has had the experience of many millennia longer than humanity in dealing with organisms related to that causing malaria, and that the foregoing arguments suggest reasons for its having a shrewd initial measure of its opponent. For such reasons natural drugs can be expected to set high standards in their efficacy.

(4) It is inherent in the present thesis, and in the morphogenetic factors in higher organisms. It may be possible to suggest whether the primary action is one of stimulation or inhibition by the range of compounds producing given effects. It was found[22] that a much wider range of molecular type was compatible with substances acting as inhibitors than with their acting as promoters of reactions, and in explanation it was pointed out that in the first case it was requisite only for the substance, for example, to combine with an enzyme, while in the second case both combination and subsequent specific changes were necessary.

(5) Many drugs have more than one action, susceptible in some cases to differentiation at both

CLASSIFICATION OF TYPES OF ACTION IN PHARMACOLOGY AND RELATED SCIENCES

Explanatory notes are given in square brackets; round brackets indicate that the allocation of the effect to a particular class is speculative.

Action through:		Examples in which the normal function of the subject is: *Restored or maintained*	*Disturbed*
I. Promoting enzyme-processes	As coenzyme, or important part of it	Vitamins B_1, B_2; nicotinic acid (other vitamins[21] and trace-elements) [normal effects]; (non-protein hormones)	Vitamins [in hypervitaminoses]
	As enzyme	Intrinsic factor of pernicious anæmia; thrombin; angiotonase, renin[22]; (protein-hormones)	toxic plant proteases[42]; anti-B_1 factor of carp[43] [relation to fox and chick]. *Cl. welchii* toxin[44]; snake venom [relation to intoxicated animal].
II. Inhibiting enzymic or analogous processes	By combination as substrate, coenzyme, or analogue	sulphanilamide, pantoyltaurine[33] [overall effect in chemotherapy]; prostigmine, physostigmine[34]; (ephedrine, cocaine)[35,35]	sulphanilamide, pantoyltaurine[33] [effects on parasite in chemotherapy]; (avidin)[45]; CO; phloridzin.
	By other combination	acriflavine[36] [overall effect in chemotherapy]	acriflavine [effect on parasite] (phytic acid)
	Through biochemical action		guanidinoacetic acid[47]; alcohol[48] [some effects on other systems through lack of labile methyl groups and vitamin B_1]; notatin[36].
	Physical changes		narcotics [certain actions due to protein denaturation][37].
III. Removing inhibition of enzyme systems	Supplying coenzyme or substrate	*p*-aminobenzoate, pantothenate[33] [effects on parasite in chemotherapy with sulphanilamide and pantoyltaurine]	*p*-aminobenzoate, pantothenate[33] [effects on host in chemotherapy with sulphanilamide and pantoyltaurine].
	Physical changes	light [upon CO-inhibition of iron-porphyrin systems] pressure [upon narcotized bacteria][37]	
IV. By-passing enzyme systems	Supplying product of enzyme	p.a. factor of pernicious anæmia; oxaloacetate [to vitamin B_1-deficient organisms][38]	
	Supplying material simulating enzyme	methylene-blue, phenazine derivatives[26,39] [effects on parasite in chemotherapeutic interference]	methylene-blue, phenazine derivatives[39] [effect on host in chemotherapeutic interference]
V. Altering or destroying enzyme system or components		pantoyltaurine-resistance in *C. diphtheriæ*[40]; NaF-resistance in *Propionibact. pentosaceum*[41] (other drug resistance) [by biological reaction to environment]	some effects of heat[49] and irradiation[50] [direct effects of environment; restored by coenzymes or nutritional factors].

table, that an organism is a balanced system the ordinary behaviour of which can be disturbed by either excess or deficiency of normal constituents or functions. Thus the promoting of an enzyme process by a drug, or any other of the actions I to V of the table, may result in either disturbance or readjustment of a system. When the system is the more complex one of chemotherapy, concerning host and parasite, the two processes are proceeding simultaneously in its different biological components. Though in this case the components can be relatively easily separated for experimental demonstration of the action of the drug upon each of them individually, agreement upon which is primarily affected by the drug has in many cases not yet been reached[29]. Comparable problems are encountered in the study of hormones and pharmacological and biochemical levels. A given biochemical effect, however, would itself lead to varying pharmacological effects with varying location of the system affected. Chemotherapy, again, offers interesting examples in the actions of the sulphonamides, which by inhibiting a pathogen can prevent the production of, for example, hæmolysins and death of the host; but by inhibiting normal intestinal micro-organisms can *cause* nutritional deficiency and again a hæmatological disturbance in the host[30]. The actions have characters in common which suggest their biochemical identity. Such complexity emphasizes that considerations of the present type provide only one link, though the primary one, between the administration of a substance and the final therapeutic response.

Conclusion

We have now the privilege of building upon the empirical findings of pre-scientific workers; upon the wholesome activities of those who swept pharmacy clear of magic and confusion; and upon the freshly gathered though still largely empirical results of the past fifty years. This paper has attempted to acknowledge our debt to each of these classes of investigator but in particular to connect the wider aspirations of the first with the experimental findings of the last of these groups. To earlier workers, who produced their effect by taking material from one organism and applying it to another, it was more apparent that connexions might exist between the origin of drugs and their actions. It was necessary to separate these two aspects for their initial scientific investigation, and views narrowed. An author, while giving as his aim the discovery of the laws of interaction between drugs and cells, limited himself to physico-chemical methods and interpretations; the study of drug-antagonism was divorced from the natural origin of the drug and the antagonist; text-books of chemotherapy were arranged according to the chemical structures of the agents. A conclusion supported by this paper is that for the understanding and theoretical presentation of pharmacology and chemotherapy, biochemistry and general biology are among the most immediately relevant sciences.

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FUNDAMENTAL CONCEPTS OF NATURAL PHILOSOPHY

IN his recent James Scott Lecture, delivered before the Royal Society of Edinburgh, on "The Fundamental Concepts of Natural Philosophy" (*Proc. Roy. Soc. Edin.*, 62, Pt. 1, No. 2. Pp. 10–24. 1*s.* 3*d.*), Prof. E. A. Milne gave a comprehensive sketch of the theory of kinematical relativity which, with his collaborators, he has been developing during the last dozen years. The lecture contained no essentially new material, but it gave a very useful summary of the scope of the theory, with attention concentrated on the fundamental ideas, and its appearance marks a suitable occasion for forming an estimate of the significance of this new approach to the basic problems of natural philosophy.

The most fundamental concept of the scheme is that of the 'substratum', which is an idealized system of relatively moving particle observers, indefinitely numerous and each provided with a clock which he can graduate, in the first instance at pleasure. All such observers can send beams of light to the others and receive them back, by which means they become aware of the readings of the others' clocks, and they agree so to graduate their clocks that, for every pair of observers, A and B, "the totality of observations A makes on B coincide with the totality of observations B can make on A". They are then said to be "equivalent". Now suppose they wish to observe an external object. Each observer must (*a*) emit a beam of light at a time t_1 by his clock, and (*b*) observe his clock reading, t_2, at the instant at which he thereby observes the object. He must then form two specified independent functions of t_1 and t_2, involving the choice of a particular value for a conventional constant, c, and these functions he calls the *distance* and the *epoch*, respectively, of the object. Successive observations give a series of values of distance and epoch, and the relation between these constitutes the equation of motion of the object. The *law* of motion (or law of gravitation in the general case) is then determined by the condition that the totality of motions in the universe shall be described in the same way by all substratum observers; that is to say, if A observes an object at

distance r and epoch t as determined by his clock, B must also observe an object (not necessarily the same object) at distance r and epoch t as determined by *his* clock. "Gravitation", writes Prof. Milne, "is only the name given to the inevitable way in which particles must move in one another's presence and in the presence of the rest of the universe, if they are to move according to the same rules for all equivalent observers in the universe".

The function of the substratum is thus to provide a stage for the display of natural motions; it corresponds in this theory to Euclidean space in ordinary geometry or to space-time in Minkowskian kinematics. It is not something which actually exists in the naïve sense of the phrase, but a conception which serves to determine the form in which observations of actually existing bodies shall be tabulated, and to define the sphere of possibility of actually occurring motions. "The theoretical, the ideal, the abstract substratum", writes Prof. Milne, "this system of moving particles, monads, observers . . . possesses a great many strange and surprising properties. . . . Just as the Euclidean plane is the stage, the scene, the background against which the phenomena of geometry—its figures and its theorems—display themselves, so the substratum is the background against which the phenomena of dynamics and gravitation display themselves".

Against this background, then, the actual bodies of the universe are to be contemplated and their behaviour observed, and here we encounter an ambiguity which I have invariably felt in reading Prof. Milne on this subject, and which remains unresolved here. Just as the Euclidean character of space tells us nothing about the number or distribution at any moment of the objects observable in space, so one would expect that the characteristics of the theoretical, ideal, abstract substratum would tell us nothing about the number or distribution of practical, real, concrete objects which present themselves for description in terms of it. This, however, appears not to be so. The behaviour of a free particle is determined not only by the demands of the observers in the substratum, but by the "rest of the universe"—that is, all the other concrete particles—also: and, furthermore, the "rest of the universe" is controlled, in both content and behaviour, by the condition that the substratum observers shall give the same general description of the whole. When one asks the reason for this, however, the answer is puzzling. We cannot deduce the motion of a single free particle without considering the rest of the universe, says Prof. Milne, for "if we are asked what is the motion of a free particle in 'empty space', *i.e.* in the presence of one observer alone, the question is an illegitimate one, and we cannot answer it". But we do not ask what is the motion of a free particle in the presence of one observer alone, but what is the motion of a single concrete particle in the presence of all the ideal substratum observers, and no reason is given why we cannot state it. We can only assume that the universe cannot contain only a single particle, because if so the substratum observers could not give the same account of it; but it would have been more satisfactory if this had been plainly stated.

The theory proceeds to deduce the way in which the universe must be populated with concrete bodies, and how those bodies must move in one another's presence, in order that it shall conform to the requirements of the substratum. This, of course, involves much mathematics, of which the chief conclusions are given in the lecture, and we reach a point at which the resulting "law of gravitation" can be compared with the familiar Newtonian law. The classical "constant of gravitation" turns out to be a function of time, but it can be made to "masquerade as a constant" by a transformation of the time-scale to that used by Newton. The deductions of the theory, however, are at present of less interest than the foundations, and we turn to an examination of the fundamental postulates.

It must be admitted that Prof. Milne speaks no more than the truth when he describes the substratum as possessing strange and surprising properties. We have become accustomed to 'spaces' which turn back on themselves and do other queer things, and it is an axiom of general relativity that the properties of space vary with its material content—that space, in fact, is less aptly described as a frame into which bodies must fit than as a garment shaped to their figure. But of all previous thinkers who have taken liberties with space, none, so far as I know, has given it intelligence. The substratum, however, is *essentially* intelligent. Each particle of it is necessarily accompanied by an observer—*is*, in fact, an observer, since it has no function but that of observing, recording and calculating. "Observers are an essential element in the situation", writes Prof. Milne. Nor is "observer" here merely a picturesque term for "observing instrument", as in the popular accounts of Einstein's relativity. The substratum observers must not only record the pointer-readings of clocks; *they must also agree to give the same value to a conventional constant, c*, otherwise their readings are useless. This cannot be done without communication by means of an agreed conventional language, and for this minds, and not merely instruments, are essential. We cannot escape from this, nor, apparently, does Prof. Milne wish to do so, for he states as one of his two principal motives throughout the work, "the attempt to say exactly what is meant by a quantitative statement in terms of operations that could be actually carried out, and communicated to a distant observer elsewhere in the universe, who could repeat similar observations, on these instructions, himself".

Parenthetically, it is worth while to point out a common misunderstanding, which Prof. Milne seems to share, concerning the meaning of 'observer' in Einstein's theory of relativity. It is often said that the purpose of the theory is to reconcile observations of observers in relative motion. That is a mistake, arising from a well-meant but unfortunate device widely adopted for explaining the theory in an attractive way. What the theory actually does is to prescribe how a single observer must change his measure numbers when he changes his co-ordinate system; for example, when (absolute motion having no significance) he changes his arbitrary standard of rest from one body to another. As a theory based on experience it can obviously do no more, for we have measurements of only one observer—a terrestrial one. The Michelson-Morley experiment did not compare observations by terrestrial and solar observers. It showed that the single result obtained by a single observer was to be expected, no matter whether that observer regarded himself as at rest or as moving round the sun. Of course, we can deduce what the theory would require a solar observer to measure if he used the same kinds of instruments and the same rules of calculation as ourselves, and the

deduction, like any other, might turn out to be incorrect if we ever succeeded in observing a terrestrial experiment from the sun. In that case the theory would have to be revised. The essential point is that hypothetical observers play no part in the theory *per se*. Anything we may say about them has the character of a scientific romance.

If the substratum postulate referred to above were shown to issue in the actual laws exhibited by moving bodies, and to form a simpler axiomatic basis than any other so far devised, it would have to be given serious attention. We might try to reformulate it so as to bring it more into line with general physical convention, but if we failed to do so, no plea of apparent absurdity would justify its rejection. We have learnt—or should have learnt—by now that nothing is too fantastic (that is, contrary to expectation) to be true. But this would not at all win Prof. Milne's approval, for it would subject the postulate to the test of *experience*, and its significance to him is that its validity is *beyond* experience ; the postulate is advanced as self-evident and inevitable. The other of his two principal motives already mentioned is "the desire never to introduce, unsuspectedly, any elements of *contingent* law". He proposes in his lecture to show how "we are led to quantitative laws relating phenomena in the external world which are *inevitable* [my italics] relations between the elements of perception". "The more advanced a branch of science", he writes, "the more it relies on inference and the fewer the independent appeals to experience it contains. . . . The question arises as to whether this process of inferring can come to a stop, and if so, where. Is there an irreducible number of brute facts derived from observation ? . . . The answer seems to me to be that we can reduce the appeals to *quantitative* experience to zero".

My mind must be made on a different pattern from Prof. Milne's, for the necessity of the substratum as a background for phenomena does not appear to me at all self-evident. I find myself capable of doubting the possibility of existence of the army of equivalent observers, of doubting their significance for natural philosophy or anything else if they did exist, and of doubting the ability of stars and planets to know where the decisions of the substratum conference required them to be. I have a conviction that, like Adam in Blanco White's sonnet, I should not have known that the universe contained numerous bodies outside the earth if no one had observed them. I am not persuaded that Einstein "still relied on an empirical assumption—the constancy of the speed of light—in his derivation of the Lorentz formulae, not realising that the same ideas could be developed further so as to dispense with this assumption". It seems to me that this "empirical assumption" was nothing more than a statement of the time-scale adopted in relativity theory, just as Newton's First Law of Motion is a statement of the time-scale adopted in classical theory, and the substitution for it of an animistic philosophy in which the same constant is adopted as a convention by hypothetical observers instead of as a unit of measurement by actual ones seems to me neither an improvement nor a logical necessity. In short, while I am perfectly ready to adopt Prof. Milne's postulates as an axiomatic basis for physical theory if he can show that they lead to a simpler and more comprehensive correlation of experience than any other, and very much hope that he will be able to give his voluminous and elegant mathematical work some acceptable meaning, I retain sufficient imagination to conceive, and liberty to choose, postulates of very different character.

Finally, I find it impossible to understand what Prof. Milne means by his claim that he has said "exactly what is meant by a quantitative statement in terms of operations that could be actually carried out". Having, through the kindness of the General Electric Co., recently acquired the charge of a particularly bright lamp, and having access also to a Riefler clock and other ticking devices, I felt myself in a position to become an "equivalent observer", and began to consider how I should set about deriving the laws of the universe. The first step was to send a beam of light to another such observer, but, having noted the instant by the clock at which my lamp was uncovered, and, just to emphasize its arbitrariness, decided to move that c be given the value $2{\cdot}99796 \times 10^{10}$, I found I could get no further, for the next observer failed either to pick up my beam or else to send it back to me. This, perhaps, was only to be expected, since he was theoretical, ideal, abstract, but it left me in a dilemma : I could not communicate with an equivalent observer since he did not exist, and it was useless to communicate with a possibly existing observer (say on Mars) since he was not equivalent. My clock jeered at me in the old Greenwich rhythm, and I could not even begin to measure the first distance and epoch.

What was to be done ? In all sincerity, I do not know. I can understand that it *would* be possible "in principle" for me to carry out Prof. Milne's instructions if the theoretical observers existed and were complaisant, though I am not so clear why, if he can reduce the appeals to quantitative experience to zero, he makes this superfluity a principal guiding motive. But the fact is that there is still a great deal about the universe that I do not know and would very much like to know. I am prepared to accept any indirect procedure which can be shown to yield the same result as the ideal one, but Prof. Milne has described none and I can imagine none myself. So I remain unable to understand what is meant by the claim that the meaning of quantitative statements has been stated "in terms of operations that could be actually carried out".

HERBERT DINGLE.

BUDGETARY AND DIETARY SURVEYS

A WHOLE-DAY Conference of the Nutrition Society was held on February 5 at the London School of Hygiene and Tropical Medicine to discuss "Budgetary and Dietary Surveys of Families and Individuals". The meeting was devoted in the main to a consideration of different methods of conducting such surveys and their comparative value.

The Society is doing valuable work in bringing together social workers and experts interested in different aspects of the subject of nutrition and able to speak from knowledge and experience. Thus each comes to view the problems which arise with a due sense of proportion and to correct the impression which might otherwise be formed that one particular approach to a solution is all-important. As Sir John Orr, who presided, pointed out, food will occupy a key position in post-war reconstruction. The Prime Minister put it first in his Guildhall speech. It is essential, therefore, that all the relevant facts should

be assembled in good time to put before legislators. Papers were contributed by Dr. E. R. Bransby (Ministry of Health), Mr. A. G. Jones (Ministry of Food), Mr. L. Moss (War-time Social Survey), Mr. F. Le Gros Clark (Children's Nutrition Council), Prof. A. L. Bowley (Institute of Statistics, Oxford), Prof. Major Greenwood (London School of Hygiene and Tropical Medicine), and Mr. D. Caradog Jones (University of Liverpool).

A fundamental question was raised at the outset by Mr. A. G. Jones: Are household budgets suitable instruments for the assessment of nutritional welfare? In his very competent analysis of the difficulties encountered in such inquiries, a number of points were stressed to which the Conference returned again and again in different contexts. The following are typical examples: (1) If the household is the unit of measurement, the food consumed may be adequate for the household as a whole but not adequate for every individual in the household. (2) The food consumed may be adequate in the week sampled, but not adequate in subsequent weeks. (3) To measure the food actually consumed in a selected week, account must be taken (*a*) not only of the food bought that week, but also of the food saved from any previous week or kept for consumption in any future week; (*b*) of home-grown and home-made food, and of food obtained free of charge; (*c*) of food eaten from home and of food eaten by visitors; (*d*) of food wasted and food values reduced in preparation and cooking. (4) Accuracy in the conversion of food, raw and cooked, of which only the price or weight may be known, into terms of nutritional value is not easy to achieve. (5) The food requirements of individuals vary with age, sex, and other less obvious factors.

Although there are ways of meeting such difficulties, it is clear that they call for an exceptional degree of willing co-operation on the part of housewives if they are to be met at all satisfactorily. It was not surprising, therefore, that some speakers expressed doubt whether nutritional surveys of families could be of any real value. This, as Dr. Bransby pointed out in an illuminating paper on studies of food consumption, is to misinterpret the function of family surveys. Their purpose is not to provide information on individual intakes, but "to enable estimates to be made of the food consumptions and adequacy of nutrient intakes of groups of families according to such factors as income and family size". Two distinct methods were used experimentally in surveys of this kind during the early part of the War by the Ministries of Food and Health: namely, the precise or weighing method, and the log book. As a result of this experience the first method was discarded as too slow and laborious, and the log book method has now been in use with success for nearly four years. Another serious objection to the weighing method is the involved technique, which makes it practically impossible to obtain the co-operation of a properly selected random sample of housewives. Dr. Bransby and others thought that dietary surveys should become part of wider and more detailed investigations, to which clinical, biochemical, sociological, and other data could be related. For this it would be essential to make the individual the unit of inquiry. With experience thus accumulated it might be possible to ascertain the precision that can be attached to nutrient intakes calculated from prepared food tables.

Prof. Greenwood drew a distinction between nutrition studies of stable groups and those of unstable groups in the population. The fundamental aim of all such studies is to discover what he called "the energetic cost of life and work". It has been long since established and repeatedly confirmed by experiments in widely different areas that, for a stable group, the normal daily calorie intake is in the neighbourhood of 3,000 per man, with a coefficient of variation of 10–14 per cent. Accordingly, in his opinion, the most valuable type of study to be undertaken now is that of an unstable group where danger to health or growth is threatened. If the mean calorie intake falls continuously below a critical value of 2,600, or if the coefficient of variation rises much above 14 per cent, disaster might almost be predicted within the observed group. Two recent surveys of mining households in the north of England were instanced, where the calorie average was 2,830–2,860 with a coefficient of variation of about 20 per cent. Prof. Greenwood ended by stressing the necessity for a rigid application of the random sample principle in nutritional surveys.

The problem is to secure a random sample, if scientifically precise methods are to be used in determining individual needs and consumption, especially in view of the fact that among the very poor, whose need is greatest, precision is most difficult to achieve. Moreover, the psychological reactions of the individual observed may also prejudice the results by their influence on veracity or consumption. There is clearly need for experiment in this field, with small but carefully chosen groups in different parts of the country and different strata of the community, to discover the best methods of approach and the most promising technique to adopt. The results of work recently done by the Ministry of Health in collaboration with the Ministry of Food and the War-time Social Survey, of which Mr. Moss gave some account, are both interesting and useful, but this has been related primarily to administrative needs: the methods used were not exact enough for a scientific study of nutritional problems.

In contrast, the Conference had an academic exposition by Prof. Bowley of the fitting of a straight line to a set of statistics relating expenditure on a particular commodity to the total available income in a suitably selected sample of households. Such research clearly has an important place in the development of knowledge about nutritional needs and habits. Attention was directed also to the actual and calculated range of variation on either side of the average expenditure within a selected sample. In the discussion which followed, Dr. Bradford Hill remarked that there has been too great a tendency to confine records of expenditure and consumption to averages of the observations sampled. He put in a plea for the more general publication of the complete frequency distribution, so that the amount of dispersion about the average might be estimated. He took a sensible middle line between those who only favoured small samples, on the ground of greater accuracy, and those who favoured large because the small were seldom in effect random. Incidentally, Dr. Yates of Rothamsted, who had just returned from the Continent, expressed the opinion that nutrition surveys in occupied countries would be of considerable help to the administration immediately after the War if carefully planned now. He and others urged the need for greater uniformity in the conduct of surveys and the treatment of data; comparable results can only be obtained by co-ordinated team work.

The final contribution to the general discussion was a series of tables concerning human needs and related vital statistics, presented by Dr. B. Woolf of the University of Birmingham. He had prepared lantern slides beforehand, and his running commentary on each table of figures thrown on to the screen introduced a touch of light comedy into the proceedings. It was not perfectly clear whether his remarks were to be taken seriously, for he questioned in turn estimates made by Sir William Beveridge, Mr. Rowntree, Prof. Bowley, the British Medical Association Committee on Nutrition, and others, hitherto accepted as authoritative. The present writer, in the course of a paper comparing the relative amounts of family expenditure allotted to food and other commodities, had applied a slightly amended estimate of Sir William Beveridge's subsistence scale to determine the bare cost of living of a family of four persons. The estimate for food, criticized by Dr. Woolf, was based on the scale recommended by the League of Nations Technical Commission on Nutrition as interpreted in the Beveridge Report.

As Dr. Bransby pointed out later in discussion, practical and reasonable diets were drawn up in conjunction with dietitians to conform to this scale, and the diets were costed on the basis of the Ministry of Labour food prices in 1938. If such figures are not accepted, where do we stand ? In the same paper an attempt was made to focus particular attention on a practice which is perhaps not generally recognized. In estimating a subsistence standard, only the cost of food is based strictly on need ; the other figures are determined by what is customary rather than by what is strictly proved from first principles to be necessary. The cost of items other than food in the above-mentioned paper was, in fact, closely related in each case to what the poorer families in the towns of Great Britain actually do spend (not what hard-hearted statisticians think they ought to spend) on these items, judging by the best available evidence, namely, the extensive and representative sample of household budgets collected by the Ministry of Labour in 1937–38.

Sir John Orr, at the end of the meeting, reviewed the difficulties involved in making dietary surveys. On the basis of experiment there could be no doubt as to the benefit children received when protective foods were added to their diet, and the British Government is committed to the task of improving nutrition to an optimum health level. The desired standard could not be reached for some years. We should need to produce more food ourselves and to import more. The whole problem of the organization of agriculture and the prices of foodstuffs must be settled. How much will the country have to pay the farmers to produce what is necessary ? Furthermore, in estimating needs we must not be too academic. People cannot be blamed for choosing to spend on other pursuits, to enliven dreary lives, part of the weekly income which might otherwise be spent on food. The solution, he suggested, is so to adjust finance and wages that there would be enough money for all to buy food and other necessities and to leave a reasonable margin for pleasure.

The Conference is to be resumed in May to discuss the results of the analysis of diets consumed in institutions, also various methods used in the preparation and cooking of food, and the laboratory assessment of the nutritional value of meals.

D. CARADOG JONES.

OBITUARIES

Prof. Yandell Henderson

YANDELL HENDERSON, whose death at the age of seventy occurred on February 18, held in succession the chairs of physiology and of applied physiology at Yale University. Although his investigations embraced many aspects of the physiology of the circulation and respiration, he will probably be best remembered for his advocacy of the value of carbon dioxide as a respiratory stimulant in a variety of clinical disorders.

Early in his career, Henderson's attention was attracted to the problem of surgical shock and to the failure of the circulation associated with this. This, he saw clearly, must be due to failure of the venous return to the heart, but the generally accepted idea that this was dependent on failure of the vasomotor control of the arterioles afforded him no adequate explanation. He noticed, too, that the venous return and the output of the heart could be greatly diminished by undue reduction of the carbon dioxide content of the body brought about by over-ventilation of the lungs, and that the venous congestion in the alimentary tract, and the paralysis of normal peristaltic movement when the abdomen was opened and the intestines exposed, was dependent on serious loss of carbon dioxide from the tissues by diffusion into the surrounding air. He was thus led to develop his theory of a veno-pressor mechanism independent of, but supplementary to, the arterial vaso-motor system, a mechanism which was dependent on the maintenance of an adequate concentration of carbon dioxide in the tissues. Although at first he was inclined to think that the explanation of this mechanism might be found in the effect of carbon dioxide on the veins, he soon developed a much wider theory, namely, that the maintenance of an adequate venous pressure was essentially bound up with the maintenance of normal reflex muscle tonus, and the support given by this to the veins and capillaries ; and that anything which interfered with muscle tonus must lead to failure of the venous return to the heart.

Henderson had a profound admiration for J. S. Haldane, but it was not until 1910 that the two met for the first time at the International Physiological Congress held in Vienna. Here they planned an expedition to Pike's Peak, Colorado, to study the effects of high altitude and the factors involved in acclimatization, and this expedition was successfully undertaken in the following year. Thenceforward Henderson and Haldane maintained a close friendship, and Henderson's frequent visits to Europe brought him into contact with others, such as Barcroft of Cambridge and Krogh of Copenhagen, whose scientific interests were similar to his own.

The publication of Haldane and Priestley's classical paper in 1905 had already established the fundamental facts of the chemical regulation of the breathing, and had emphasized the physiological importance of carbon dioxide in this connexion. The significance of this work was fully appreciated by Henderson. It was indeed in harmony with his own work on the part played by carbon dioxide in the regulation of the circulation, and in a succession of papers he made a considerable contribution to the problem of the regulation of the acid-base equilibrium in the blood, with which respiration was closely connected. This in turn led him directly to a study of methods of resuscitation in cases when, for one reason or another, the

The vacancies advertised in these columns are available only to applicants to whom the Employment of Women (Control of Engagement) Orders, 1942-3, do not apply.

BIRKBECK COLLEGE
(UNIVERSITY OF LONDON)
AUTUMN TERM BEGINS ON FRIDAY, SEPTEMBER 15

Applications for admission from men and women who desire to read as Internal Students of the University at the week-ends for degrees in the Faculties of Arts, Science and Economics or for the Diploma in Geography should be addressed to The Clerk, Birkbeck College, E.C.4.

THE UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG
PROFESSOR OF PHILOSOPHY

Applications are invited for the appointment to the Chair of Philosophy. The Department of Philosophy at present provides courses in Ethics, Logic, Metaphysics and Political Philosophy, primarily for B.A. and Honours students, and a course in the History and Philosophy of Science for B.Sc. students. The staff consists of the Professor and a Lecturer.

Assumption of Duties.—January 1, 1945, or as soon as possible thereafter. Applications will be welcomed from candidates who, being engaged in military service or other national service may be precluded from assuming duties on the date mentioned. Steps will be taken by the University for the release of such a person if appointed.

Salary.—£860 per annum rising by annual increments of £30 to £1,100 per annum (plus temporary cost of living allowance). The salary is subject to 6 per cent deduction for Provident Fund Contributions, Government and University together contributing an equal amount. Half salary will be paid from date of embarkation to date of assumption of duties in Johannesburg.

Transport.—£100 will be contributed towards the cost of passage and first class rail fare will be refunded for the journey from Cape Town to Johannesburg.

Further information with reference to the University and living conditions in South Africa may be obtained from the University's London Representative, Dr. William Cullen, at 4 Broad Street Place, London, E.C.2, with whom applications (in duplicate) must be lodged not later than May 1, 1944.

ROYAL COLLEGE OF SURGEONS OF ENGLAND
W. H. COLLINS PROFESSORSHIP OF HUMAN AND COMPARATIVE PATHOLOGY

The Council of the Royal College of Surgeons of England invites applications for the W. H. Collins Professorship of Human and Comparative Pathology.

The salary will be £2,000 per annum.

The principal duty of the professor will be the care and demonstration of the pathological collections. He will also be expected to promote the advancement of knowledge of the diseases of man and animals by original investigation, and by instruction in the methods of research. At this juncture the main requirement of the College is the restoration and reorganization of its Museum. For this work suitable assistance will be provided. The election is an open one, but the Council reserves the right to invite individual applications.

Particulars and terms of appointment may be obtained from the Secretary. Applications with the names of two references must reach the College not later than July 31, 1944.

Lincoln's Inn Fields, KENNEDY CASSELS,
London, W.C.2. Secretary.

MINISTRY OF LABOUR AND NATIONAL SERVICE

Applications are invited for a temporary appointment of Assistant Chemist for the Shellac Research Bureau at Edinburgh. Initial period of employment April 3, 1944 to March 31, 1946, terminable at six months' notice by either side. Salary in a scale of £250–20–£550 per annum plus war bonus at present 19s. per week. The selected candidate will enter scale according to qualifications and experience.

Candidates should be graduates of a British University or should possess equivalent academic qualifications and should preferably have had experience or research work on resins.

Applicants should write for application form to the Ministry of Labour and National Service, Central (Technical and Scientific Register, Advertising Section, Alexandra House, Kingsway, London, W.C.2, which must be returned by March 31, 1944. The reference number F. 1994A should be quoted.

UNIVERSITY OF ST. ANDREWS
UNITED COLLEGE, ST. ANDREWS
CHAIR OF NATURAL PHILOSOPHY

The University Court of the University of St. Andrews invites applications for the Chair of Natural Philosophy, United College, St. Andrews, which will become vacant owing to the retiral, on September 30, 1944, of Professor Stanley Allen, F.R.S.

Physicists at present engaged on National Service and who, in consequence, are not in a position to take up duty immediately, are not thereby precluded from being considered for the appointment. The date on which the appointment becomes operative will depend on when the professor is available to take up duties.

Candidates are requested to submit notice of their intention to apply for the vacancy as soon as possible to the undersigned, and not later than June 15, 1944. Candidates are requested to submit at least three testimonials, or, alternatively, to give the names of three referees. The initial salary attached to the Chair is £900 per annum increasing, in accordance with the conditions of appointment, to £1,000. It is hoped that the associated appointment of Director of the Physics Research Laboratory, St. Andrews, to which a stipend of £100 per annum was attached, will be operative in peace conditions. Further conditions of appointment may be obtained on request.

The University, DAVID J. B. RITCHIE,
St. Andrews. Secretary
March 1, 1944.

MANCHESTER UNIVERSITY AGRICULTURAL ADVISORY DEPT.

Applications are invited for the post of Assistant to the Advisory Chemist. Candidates should possess a degree in Agriculture and have a knowledge of Chemistry. Experience in soil analytical methods and laboratory technique is essential. The appointment is temporary and is not superannuated. Salary £275–£375 per annum plus bonus according to qualifications. Applications with copies of two recent testimonials should reach the undersigned by Saturday, March 18.

ARTHUR JONES,
Chief Advisory Officer.

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

Applications are invited for the post of SUPERINTENDENT of the METALLURGY DEPARTMENT of the NATIONAL PHYSICAL LABORATORY. Candidates should have considerable research experience in metallurgy and should also have a broad outlook on the possibilities of research applied to industry. The salary contemplated is up to £1,250, but the starting salary would depend on qualifications and experience. Superannuation provision will be made under the Federated Superannuation System for Universities. Applications giving full particulars of qualifications and experience and not less than two personal references should be sent to the Director, National Physical Laboratory, Teddington, Middlesex, not later than March 25, 1944.

UNIVERSITY OF OXFORD
READERSHIP IN MINERALOGY

Applications are invited for the above Readership and should reach the Registrar of the University not later than April 8, 1944. Stipend £750 per annum. Retiring age 65. It will not be necessary for the candidate chosen to take up his duties immediately. Further particulars may be obtained from the Registrar, University Registry, Oxford.

Boots Pure Drug Co., Ltd., invite applications for a number of vacancies in the Research Department. Candidates should have an Honours Degree in Chemistry, or its equivalent, and preference will be given to those with one or more years' research experience in organic chemistry. The undertaking is scheduled under the Essential Work Order.—Apply by letter to the Director of Chemical Research, Boots Pure Drug Co., Ltd., Nottingham, giving age, qualifications, experience, and publications.

Librarian required by well-known firm engaged in the Applied Chemical Industry. Post calls for a Lady with Library experience preferably, but not essentially with technical qualifications to work in London area under most congenial conditions.—Write Box 843, c/o Dawsons, 129 Cannon St., E.C.4.

BEDFORD COLLEGE FOR WOMEN
(UNIVERSITY OF LONDON)

The Council of Bedford College invites applications for the following post open to men and women equally, vacant as from April 1, 1944:

MUSEUM ASSISTANT in the Department of ZOOLOGY to prepare and mount specimens and make microscopical preparations, etc. Knowledge of Zoology essential. Salary £300.

For further particulars apply The Secretary, Springfield, Sidgwick Avenue, Cambridge. Last date for receiving applications, March 22, 1944.

Physicist, Ph.D., B.Sc., with engineering experience, seeks responsible post. Experience of application of science in several industries and of organizing and management of research and development, also technical education. Release agreed. Salary £800.—Box 162, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

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

Technical Editor with wide scientific knowledge and experience in book production wanted urgently.—Box 163, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

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Wanted: A.C.S. Journal December 1942; A.C.S. Abstracts, Nos. 22, 23, 24, 1942 and No. 16, 1943; Industrial and Engineering Chemistry, Industrial and Analytical Editions, December, 1942; Journal of Chemical Society, May, 1942; Gas and Oil Power, January, 1943.—Please reply Box 161, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Translations of Scientific and Technical Papers from Danish, Dutch, French, German, Italian, Norwegian, Russian, Spanish and Swedish originals. Thirty-five years experience.—George Borrow, 6 St. Stephen's Grove, London, S.E.13.

Diagrams, maps, charts, accurately prepared for publication—Mr. Peter Hood, 7 Poplar Grove, Kennington, Oxford; or c/o Kathleen Boland Studio, 11-13 Broad Court, Long Acre, London, W.C.2.

Urgently required: Diffraction grating ten divisions per 0.1 mm., Goniometric eyepiece for 23.3 mm. microscope tube. Research Department, Diamond Trading Co., Ltd., 32/34 Holborn Viaduct, London, E.C.2. CEN. 6435.

Microscopes, of all descriptions, only a few available second-hand, perfect condition. Send details of your requirements enclosing 3d. stamp.—Chards, Microscope Specialists, Forest Hill, S.E. 23.

Reflecting Telescopes: 6½" Mirrors of excellent quality £10 8s. 6d. Flat 7s. 6d.—Roland Lee, "Infield," Babell, Holywell, Flintshire.

Chemical, Physical, and Natural History Journals of every country urgently required. High prices paid. Please send particulars to The Scientific Book Supply Service, 5 Fetter Lane, London, E.C.4. (Phone: CEN 1294.)

Wanted: books on the microscope and microscopy.—Chards, Forest Hill, S.E.23.

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respiratory centre in the brain was showing signs of failure.

An outstanding instance of Henderson's shrewdness in the application of knowledge gained in the laboratory to the solution of practical problems in everyday life is afforded by his work on carbon monoxide poisoning. In severe cases of carbon monoxide poisoning, the best method hitherto advocated for treatment was by inhalation of oxygen; yet this was often disappointing since, as he showed, the respiratory centre had already begun to fail owing to the serious deficiency of oxygen to which it had been subjected because of the displacement of oxygen from the hæmoglobin in the blood by carbon monoxide. By adding 5 per cent or more of carbon dioxide to the oxygen inhaled, he found that the increased stimulus to the respiratory centre antagonized its failure, and with the maintenance of effective breathing the rate of elimination of carbon monoxide from the blood was greatly accelerated and a far better opportunity afforded for the eventual resuscitation of the victim. Oxygen – carbon dioxide inhalation is now universally recognized as the best treatment for carbon monoxide poisoning.

Henderson showed, too, that similar treatment might have a far wider application in clinical medicine when stimulation of the breathing or the maintenance of hyperpnœa might be requisite, for example, in the resuscitation of the new-born baby, in accelerating the elimination of volatile anæsthetics through the lungs after surgical operations, or in improving the breathing and reducing the risk of atelectasis in inflammation of the lungs. He had, however, an uphill fight before his views gained acceptance. Many regarded carbon dioxide as a poison the elimination of which from the lungs ought to be promoted and not hampered, and it took time to bring home the idea that carbon dioxide was also a natural stimulus to the breathing and could rightly be used for this purpose in clinical medicine.

Henderson's wide knowledge of the general physiology of respiration introduced him to many other practical problems. He was associated with the U.S. Bureau of Mines in the design of mine rescue apparatus and in the detailed investigation by which standards of ventilation were fixed for the ventilation of the Holland Tunnels between New York and New Jersey so as to prevent any risk of carbon monoxide poisoning caused by the heavy motor-car traffic. During the War of 1914–18, he worked on the physiological problems of aviation, and, after the start of gas warfare, on the properties of poisonous gases and means for securing protection against them; this led to the publication in 1927, in collaboration with H. W. Haggard, of his well-known book "Noxious Gases", a monograph which was to serve as the basis for the treatise "Schädliche Gase" by Flury and Zernik, which was published in 1931 in Berlin.

Much of Henderson's work is summarized in his book "Adventures in Respiration", published in 1938, and this affords an insight into the way in which his ideas developed and the difficulties that he faced and overcame.

A stout friend and a doughty opponent, Henderson retained throughout his working life the enthusiasm and the vigour of his youth. He had the courage of his convictions and really enjoyed a battle of words and wits, and he could speak bluntly in argument. But whether one agreed or disagreed with him, his views were always worthy of serious consideration. That he made mistakes is no doubt true, for no one is infallible; but there is no question that he played a great part in the development during the present century of our knowledge of the wide field of physiology embraced in the term 'respiration', and in the application of this knowledge to practical problems. It can rightly be claimed that his work on resuscitation has saved many lives that would otherwise have been lost. C. G. DOUGLAS.

Mr. H. H. Brindley

BY the death on February 18 of Harold Hulme Brindley, science lost a great personality. He was born at Highbury on June 17, 1865, the son of the then recorder of Hanley. Educated at Mill Hill School, he entered St. John's College, Cambridge, in 1884. Here he shared in all undergraduate activities, rowing in the boats, lieutenant in the Volunteers, president of the Debating Society, finally taking honours in the Natural Sciences Tripos in 1888. Careless of examinations, he obtained inspiration by aiding Weldon and Bateson in a period which was largely devoted to measurements designed to ascertain the technique of natural selection. An article on variation in the number of joints in the cockroach's tarsus greatly influenced Bateson, for it showed perfection with no intermediates whether there were four or five joints, each a 'normal' form, a 'discontinuous and total variation'. The facts were contested, as in regeneration a four-jointed tarsus is common, but he maintained his position, finding a case of four-jointed tarsi on all six legs. This led him later to a study of regeneration in general, especially in insects and vertebrates. His experiments on the different instars of Lepidoptera were particularly interesting.

Brindley then turned to the earwigs, with their long and short forceps. He scouted the idea that they were distinct species, a view extended to Xylotrupes beetles, two forms each with its fluctuations yet markedly discontinuous. For many years he kept cages of earwigs to experiment on their feeding habits and reactions. He found that their capture of insects by their forcipes in their nocturnal excursions was important, but they could live healthily on purely plant-food, though preferring dead animal matter. Dahlias and roses were mainly of use as hiding places, though their petals were agreeable. For their natural control, birds, except starlings, were unimportant. For proportions of sexes and other enumerations, he collected in the Scilly islands, but we recall with most interest his study of their parasitic infections. Clepsidrina abounded in the hind gut, while gordiid thread worms up to 50 mm. long often destroyed the whole gut; there were also acarine mites and fungoids, but parasitism did not produce any difference in respect to high and low males.

While collecting earwigs all over Cambridgeshire, Brindley also took the molluscs, obtaining more than a hundred species, and he observed that the progressive drainage of three centuries had not resulted in any marked invasion of Wicken Fen by terrestrial forms. Annual excursions to Arcachon were for the purpose of studying the larval processions of the moth, Cnethocampa, these first described by Réaumer. He broke up natural into artificial processions, but the question of direction is still undetermined. Mass attacks for oviposition were continuously made by tachinid flies, countered largely by the urticating properties of the larval hairs. During all these periods, indeed for fifty years, he had charge of the

first M.B. teaching in the Zoological Laboratory at Cambridge, more than five thousand students passing through his hands. He declined preferment, for the low pay of those days made private coaching necessary, while there were then no grants available for his research purposes. He became steward of his College during 1914–23, finally being elected a fellow in 1931.

Meantime Brindley had attained high distinction in other fields. He was a keen member of the Cambridge Cruising Club, and his knowledge of ships was unsurpassed. Hardy (later Sir William) had him and Graham Kerr as crew on his *Raven*, when she was the first yacht to pass westward through the Kiel Canal. He was one of the founders of the Society for Nautical Research in 1911, and he never missed a council meeting for twenty-eight years. He was a prolific writer in its journal, his chief subject the medieval ship. This and a love for St. Christopher led him to many ports and gave play to his artistic abilities, a study of medieval glass giving him great joy. He put his chief trust in engraved seals, and extended his research to every seaport in Europe. He arranged a special room for them in the National Maritime Museum at Greenwich, to which he gave his own unmatched collection. These settled the dates at which the rudder replaced the steering oar and the use of reef points. He was also an authority on primitive sailing craft.

Here was a character with a genius for friendship, equally at home in the discussions of art, literature and science, at first a noted contributor to the advance of biology, later a historian of nautical evolution, always the inimitable and humorous word-painter of the many noted personalities he had met, a real lover of life. J. STANLEY GARDINER.

NEWS and VIEWS

Prof. A. R. Todd, F.R.S.

PROF. A. R. TODD has been appointed professor of organic chemistry in the University of Cambridge as from September 1944. Prof. Todd received his early education at Allan Glen's School, Glasgow, and passed from there to the University of Glasgow where, after a brilliant academic career, he graduated in 1928 and commenced his first research under the direction of Prof. T. S. Patterson. In October of the following year he went to work with Prof. W. Borsche in the University at Frankfurt-am-Main, where as a Carnegie Research Scholar he studied the chemistry of certain bile acids, and in 1931 presented the results of this work in the form of a thesis for which he was afterwards awarded the degree of Ph.D. On his return to England, he was elected to a Senior Studentship of the Exhibition of 1851 and worked for the next three years in the research laboratory of Sir Robert Robinson at Oxford. For his researches on the synthesis of anthocyanins during this period he was awarded the degree of Ph.D. At the invitation of the late Prof. G. Barger, he moved from Oxford to Edinburgh in 1934 to take up the study of the chemical constitution of vitamin B_1. The skill with which he led his team during this period and finally determined the structure of the vitamin, and of its fluorescent oxidation product, thiochrome, established his reputation as an outstanding organic chemist.

IN 1936 the Governing Body of the Lister Institute invited Dr. Todd to continue his researches in the Biochemical Department, and for the next two years he and his co-workers investigated the nature of the groupings responsible for the characteristic physiological action of vitamin B_1 and completed the synthesis of a number of compounds structurally related to the vitamin. Dr. Todd became a reader in biochemistry in the University of London in 1937. During his stay at the Lister Institute, he continued his researches on the constitution of the anti-sterility vitamin (vitamin E) and engaged in many other topics which included the chemistry of certain anthelmintic drugs and the active principles of *Cannabis indica*. In 1938 Dr. Todd was appointed professor of chemistry and director of the Chemical Laboratories in the University of Manchester, and with the increased facilities available at this famous centre of research, he was able to engage in an ever-widening array of synthetic and constitutional problems. Prof. Todd was elected a fellow of the Royal Society in 1942. Chemists and biochemists throughout the country will wish him every success and happiness in his new appointment.

Royal Commission on Population

IT is announced that the Royal Commission on Population has been constituted as follows: Lord Simon (*chairman*); Prof. A. M. Carr-Saunders, director of the London School of Economics; Sir Hubert Henderson, of the Treasury, formerly joint secretary to the Economic Advisory Council; Prof. A. W. M. Ellis, regius professor of medicine in the University of Oxford; Dr. Ethel Cassie, formerly senior assistant medical officer of health for maternity and child welfare, Birmingham; Lord Cranbrook, deputy regional commissioner for the Eastern Civil Defence Region; Lady Dollan, wife of a former Lord Provost of Glasgow; Mr. R. C. K. Ensor, research fellow of Corpus Christi College, Oxford; Mr. J. R. Hobhouse, of Messrs. Alfred Holt and Co., Ltd., Liverpool; Mrs. Margaret Jay, a member of the L.C.C.; Mrs. Gwen Longmoor, wife of a West Hartlepool factory worker; Mrs. G. P. Hopkin Morris, wife of the B.B.C. regional director for Wales; Lady Ogilvie, wife of the former director-general of the B.B.C.; Mrs. Helen Pawson, area representative for Wales of the W.V.S.; Mr. A. Roberts, general secretary of the Association of Card Blowing and Ring Room Operatives; and Mr. W. Dunkeld Robieson, editor of the *Glasgow Herald*.

Associated with the Royal Commission will be the three following technical committees: *Statistical Committee:* Prof. A. M. Carr Saunders (*chairman*), Mr. V. P. A. Derrick, Dr. D. V. Glass, Mr. R. R. Kuczynski, Mr. J. G. Kyd, Mr. H. Campion, Mr. A. Reeder, Dr. P. Stocks, Mr. F. A. A. Menzler and Mr. G. H. Maddex. *Economics Committee:* Sir Hubert Henderson (*chairman*), Mr. E. C. Ramsbotham, Prof. Alexander Gray, Prof. J. R. Hicks, Mr. W. B. Reddaway, and Mrs. Joan Robinson. *Biological and Medical Committee:* Prof. A. W. M. Ellis (*chairman*), Prof. E. D. Adrian, Prof. D. Baird, Dr. P. H. F. Bishop, Dr. C. P. Blacker, Mr. Eardley L. Holland, Dame Louise McIlroy, Dr. A. S. Parkes, Mr. E. W. Riches,

Sir Alexander Russell, Dr. P. Stocks and Dr. J. G. Thwaites. The secretary of the Royal Commission and of the three committees is Mr. N. F. McNicoll, of the Ministry of Health.

The terms of reference of the Royal Commission are to examine the facts relating to the present population trends in Great Britain; to investigate the causes of these trends and to consider their probable consequences; to consider what measures, if any, should be taken in the national interest to influence the future trend of population; and to make recommendations.

Lavoisier Statue in Paris

ACCORDING to the July 1943 issue of the French monthly philatelic review, *L'Echangiste Universel*, a copy of which has just reached Great Britain, a 4-franc postage stamp is being issued in commemoration of Lavoisier, the centenary of whose birth occurred on August 26, 1943 (see NATURE, Aug. 21, 1943, p. 207). Incidental reference is made to the removal "depuis un an" of the bronze statue of Lavoisier which stood at the north end of the Madeleine, not far from his town house (now rebuilt), 17 Boulevard de la Madeleine. *L'Echangiste Universel* appears to have no doubt about the fate of this superb monument—the work of Barrias—for its removal is attributed, with tactful obliquity, to the "service de la récupération des métaux", and the comment is added: "Pauvre Lavoisier connut à deux réprises, les vicissitudes de l'exécution capitale".

It will be remembered that Barrias adorned the pedestal of this beautiful work of art with two bronze reliefs, one of which depicted Lavoisier at work in his laboratory with Madame Lavoisier, his capable and devoted assistant, who is said to have learnt English so that she might translate for her husband the scientific papers of his great contemporaries, Cavendish and Priestley. In the other panel could be seen Lavoisier lecturing before the Paris Academy of Sciences, with Lagrange, Monge, Lamarck, Condorcet and Laplace among his audience. Though the pedestal was standing when *L'Echangiste Universel* recorded the destruction of the statue, the activities of the "service de la récupération des métaux" in occupied countries would seem to indicate that Barrias' bronze panels, with the statue, may never be seen again.

New Mathematical Tables

THE many users and admirers of the New York Work Projects Administration Mathematical Tables always studied the impressive list at the end of each volume of further tables to be published, and looked forward to the time when much-needed values would be available. It was a great shock to them when President Roosevelt announced, towards the end of 1942, that all W.P.A. activities were to cease; it was hard to realize that such a great international asset as the wonderful New York team of computers—the greatest the world has ever known—was to be destroyed at a time when its proved usefulness might have been diverted to the war effort. Actually, although the greater part has been disbanded, a nucleus has remained in being to help the Service departments, under the sponsorship of the U.S. Bureau of Standards. Naturally there were, early in 1943, a great number of tables ready for press, but not printed. It is with feelings of relief that we learn that the publication of these has now been provided for, and that four volumes have been announced already. The first gives reciprocals of the integers from 100,000 to 200,000, and thus extends the tables of Oakes (now unobtainable) and Cotsworth, which stop at 100,000. The second is a 10-place table of the Bessel functions $J_0(z)$ and $J_1(z)$ for complex arguments, giving real and imaginary parts for $\varphi = 0(5°)90°$ and a range $0(0{\cdot}01)10$ of the modulus. The third table gives circular and hyperbolic tangents and cotangents to eight significant figures for $x = 0(0{\cdot}0001)2$; it is thus a companion to the similar values of sines and cosines that appeared in 1939. The American practice of computing by calculating machines led to a revival some fifteen years ago of the Lagrangian interpolation formula. The new tables now provided give the coefficients for interpolating with any number of points (that is, tabular values) from 3 to 11. Incidentally, they include all the coefficients of Everett's central difference formula. The tables are to be issued by the Columbia Press, Ithaca, N.Y. (in Great Britain by Scientific Computing Service, Ltd., 23 Bedford Square, London, W.C.1).

British Medical Bulletin

IN 1940 the Medical Research Council, the Ministry of Information and the editorial department of the British Medical Association decided to send abroad abstracts of important articles in British medical journals, and Dr. Howard Jones was appointed to do this work under the direction of the editor of the *British Medical Journal*. By the end of 1941 a British Medical Information Service had been formed, and the British Council, which had supported the work from its inception, took it over as a permanent part of its work. The *British Medical Bulletin* is published in English, Turkish, Portuguese and Spanish, and Dr. Howard Jones, who is now a whole-time officer of the British Council, has made it a valuable addition to medical literature.

One Hundred Years at the Cincinnati Observatory

EVERETT L. YOWELL has an interesting article with the above title in *Sky and Telescope* (3, No. 2; December 1943). He gives an account of the development of the Observatory from the days when Ormsby MacKnight Mitchel resigned his professorship of mathematics, engineering and mechanics at Cincinnati College, and later, in the spring of 1842, started giving lectures on astronomy. These lectures were so well received that Mitchel announced his intention of building and equipping an observatory; and immediately he solicited membership for a society, each member to subscribe for a share at 25 dollars. It is remarkable that in spite of many initial difficulties—lack of funds in particular—Mitchel began the erection of the building with one carpenter and one mason as foremen, and on November 9, 1842, ex-President John Quincy Adams, then in his seventy-seventh year, laid the corner stone. In January 1845 the 11-inch refractor which Mitchel had purchased in Munich arrived; it was mounted in the spring of the same year.

As the Observatory was without endowment, Mitchel agreed to act as director for ten years without remuneration. Unfortunately, he had to devote a lot of time to lecturing at the College, which provided his only means of livelihood, and in consequence he

had very little time for astronomical work. The Observatory passed through many changes, including its removal to a better site and the appointment of Prof. Ormond Stone as director in 1875. He revived the study of double stars which had been undertaken by Mitchel, but was carried out in a desultory manner owing to other responsibilities. Stone was succeeded by H. C. Wilson (1882–84), Dr. Jermain G. Porter (1884–1930), E. L. Yowell, the author of the article (1930–40), and Dr. Elliott S. Smith, who succeeded him and is now in charge. A catalogue of stars observed by Dr. Smith is nearly ready for publication, and Dr. Paul Herget has done valuable work in computing orbits for the last two satellites of Jupiter.

Penicillin

A SPECIAL issue of the *British Medical Bulletin* (2, No. 1; 1944) devoted to work on penicillin contains special articles by Prof. L. P. Garrod, Prof. A. Fleming, Prof. H. W. Florey, Dr. E. Chain and Dr. M. E. Florey, and reviews of papers published between 1929 and 1943 on the discovery of penicillin and on its chemotherapeutic action, purification and chemical properties and on clinical trials of it. An appendix deals with the Oxford Unit, the slide-cell technique and communications not reviewed in this issue of the *Bulletin* or published in other countries. Everyone interested in penicillin will find this excellent review of the subject valuable.

West Indian Conference

THE first of a regular system of West Indian conferences is to be opened in Barbados on March 21 (see p. 320 of this issue). The conference, which will be presided over by Sir Frank Stockdale, British co-chairman of the Anglo-American Caribbean Commission, will consider means of raising the nutritional level in the Caribbean area, the re-absorption into civil life of persons engaged in war employment, the planning of public works for the improvement of agriculture, education, housing and public health, health protection and quarantine, industrial development, and the Caribbean Research Council and possibilities for its expansion.

Royal Society of Edinburgh : New Fellows

THE following have been elected ordinary fellows of the Royal Society of Edinburgh: Mr. John Anthony, lecturer in botany, University of Edinburgh; Dr. Daulatrai Bhatia, senior lecturer in zoology, Government College, Ludhiana, India; Prof. David Burns, Department of Physiology, University of Durham; Mr. John G. Carr, cancer research worker, Institute of Animal Genetics, University of Edinburgh; Dr. R. W. Craig, Scottish Secretary, British Medical Association; Dr. L. J. Davies, lecturer, Department of Medicine, University of Edinburgh; Prof. E. M. Dunlop, Department of Bacteriology, University of Durham; Mr. J. M. Geoghegan, president of the Society of Accountants in Edinburgh; The Hon. Lord Gibson, chairman of the Scottish Land Court; Mr. J. Methuen Graham, surgeon, Edinburgh Royal Infirmary; Prof. Arthur Holmes, Department of Geology and Mineralogy, University of Edinburgh; Dr. D. J. A. Kerr, lecturer on forensic medicine, School of Medicine of the Royal Colleges, Edinburgh; Prof. J. R. Learmonth, Department of Surgery, University of Edinburgh; Dr. W. Ledermann, assistant lecturer and Carnegie Fellow, University of St. Andrews; Dr. A. D. McEwen, chief bacteriologist, Moredun Institute Animal Diseases Research Association, Midlothian; Dr. Robert McWhirter, lecturer in radiology, University of Edinburgh; Major Noel Ewart Odell, Clare College, Cambridge; Dr. R. F. Ogilvie, lecturer in pathology, University of Edinburgh; Prof. G. D. Preston, Department of Physics, University College, Dundee; Mr. W. S. Procter, regional engineer, Post Office Engineering Branch, Scottish Region; Dr. T. Robertson, district geologist, H.M. Geological Survey, Edinburgh; Dr. R. W. Scarff, reader in morbid anatomy, University of London; Mr. E. Openshaw Taylor, lecturer in electrical power and machinery, Heriot-Watt College, Edinburgh; Dr. O. A. Trowell, lecturer in human physiology, University of Edinburgh; Prof. J. Stirling Young, Department of Pathology, University of Aberdeen.

Announcements

THE triennial award of the Coopers Hill War Memorial Prize and Medal, which fell in 1943 to the Institution of Electrical Engineers, has been made by the Council to Mr. Harold Page, for his paper on "The Measured Performance of Horizontal Dipole Transmitting Arrays".

THE award for 1943 of the Page Prize for the best thesis submitted in lieu of the Associate Membership Examination of the Institution of Electrical Engineers has been made by the Council to Mr. J. V. Beaumont for his thesis entitled "Types of Power Transformers, with special reference to On-Load Voltage Regulators".

THE Institution of Electrical Engineers will this year make awards of the Duddell and Manville Scholarships. These Scholarships are each worth £150 a year for three years. They are open to British subjects who are less than nineteen years of age on July 1, 1944, who have passed the matriculation examination of a British university, or an equivalent examination, and who wish to take a whole-time day course in electrical engineering. Applications for particulars and nomination forms should be addressed to the Secretary of The Institution, Savoy Place, London, W.C.2. Nomination forms must be returned not later than April 15.

THE ninth Pedler Lecture of the Chemical Society will be delivered by Dr. C. R. Harington on March 16 at 2.30 p.m. Dr. Harington will speak on "Newer Knowledge of the Biochemistry of the Thyroid Gland".

A WEEK-END course for medical practitioners on factory medical services and industrial diseases will be held at the London School of Hygiene and Tropical Medicine on March 25–26. It will be opened by Sir Wilson Jameson, chief medical officer of the Ministry of Health, and lectures will be given on "Tuberculosis and the Industrial Worker", "Industrial Diseases of Coal Miners", "Medical Inspection of Canteens", "Young Persons in Industry", and "The Medical Selection of Factory Personnel". The fee of one guinea for the course should be sent to the Secretary, London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1, not later than Monday, March 20.

LETTERS TO THE EDITORS

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

Mechanism of Formation of the Fertilization Membrane in the Sea Urchin Egg

THE mechanism of formation of the fertilization membrane in the sea urchin egg has long been a matter of discussion. Runnström, Monné and Broman[1] recently reviewed the essential points in this discussion. They also resumed, on the eggs of *Psammechinus miliaris* and *Echinocardium cordatum*, the study of the birefringence of the membrane first described by Runnström[2].

The membrane presents a double refraction which is negative in the radial direction. No similar birefringence could be observed on the surface of the unfertilized egg. During the elevation of the membrane the birefringence increases until it reaches the normal value (retardation M 12 mμ).

Unfertilized eggs transferred to hypertonic solution (2 ml. sea water + 0·6 ml. 2·5 N sodium chloride) sometimes form a membrane which is more or less granular and the birefringence of which is considerably lower than that of the normal fertilization membranes. The granules in question seem to be identical with the 'cortical granules' of the unfertilized eggs. These granules are formed at the maturation of the egg. They disappear at fertilization, as was observed by Hendee[3], Lindahl[4] and Moser[5]. The cortical granules are easily observed in sections of unfertilized mature eggs fixed with Fleming's solution and stained with hæmatoxylin.

The sperm of sea urchin was frozen, dried *in vacuo* and extracted with methanol. The residue was treated with sea-water at 90° for three minutes. The extract thus obtained[6] (containing 0·5–0·7 mgm. N per ml.) interferes even in considerable dilutions (1 : 200–1 : 300) with the normal membrane formation, without inhibiting the entrance of the sperm and the copulation of the pro-nuclei. The division of the nuclei always proceeds, while the segmentation of the cytoplasm is more or less inhibited.

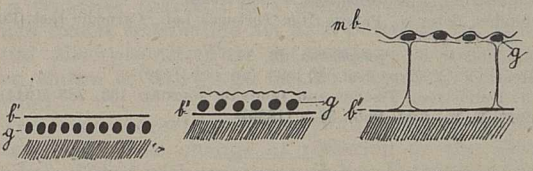
The inhibition of membrane formation occurs in many different degrees (1–4) according to the concentration of the sperm extract. (1) No membrane separates from the egg surface. Even when the eggs are transferred to a hypertonic solution, no membrane becomes visible. Occasionally, however, an elevation of a thin membrane occurs, which is localized at a part of the egg surface.

(2) A membrane is formed, but the perivitelline space of the egg surface is very narrow. In a hypertonic solution, the membrane is seen to be fully separated from the egg surface. The membrane of these eggs is granular and its double refraction is rather low, the retardation amounting only to about half the normal value. Eggs of this kind have been fixed and stained. In eggs with granular membranes no cortical granules are present. The granules of the membrane, however, are stained in the same way as the granules present in the surface of the unfertilized eggs.

(3) The perivitelline space has the normal width. The membrane is somewhat folded or curled, but no granules are visible. The double refraction is not different from that of a normal, smooth membrane. Intermediate stages between (2) and (3) are observed. In these, one part of the membrane may be granular, another part curled, without visible granules. The granules evidently elongate in a tangential direction and enter as an element of the membrane. *The double refraction of the fertilization membrane reaches its normal value only when the granules have been incorporated with the membrane.*

(4) In most diluted solutions of sperm extract a normally raised, smooth membrane may appear. Intermediates exist, however, in which one part of the membrane is curled or even granular, the other being smooth and of perfectly normal appearance.

It seems reasonable to assume that the observations described above under (1)–(4) represent different stages in the normal formation of the fertilization membrane. This view is strongly supported by observations on unfertilized eggs of *Echinocardium cordatum*, which have been transferred to a mixture of 7 parts sea-water and 1 part rabbit or sheep serum. In this mixture perfectly smooth membranes are formed, but the process gradually passes through the four stages described above. Only after about fifteen minutes from the beginning of the process are the normal smooth membranes formed.



These and a number of further observations give a fairly precise picture of the formation of the fertilization membrane. The first step of the membrane formation may be illustrated by the accompanying schematic diagrams. In (1), representing the conditions before the activation, the cortical granules (g) are situated below the limiting border (b') of the egg. This border is characterized optically by its refringence. With dark-ground illumination, the border is seen to have a yellow-orange colour. The activation involves a reorganization of the peripheral part of the cortex. The border retracts, leaving outside itself a rim of hyaline substance in which the radially, somewhat elongated, cortical granules are found (cf. 2). Simultaneously with this retraction the orange colour of the border changes to a bluish-white, as observed with dark-ground illumination[1,2]. The state represented by (2) could be well recognized in Echinocardium eggs. The rim still adheres to the limiting border (b'') and is not separated from this when the eggs are immersed in hypertonic sea-water.

At fertilization, the retraction starts from the entrance point of the sperm cell and thence spreads over the egg surface in a wave-like manner, as described by Just[7]. About ten minutes after fertilization, the hyaline layer becomes visible on the surface of the normal egg. It is obvious that the formation of the hyaline rim of (2) and that of the hyaline layer are quite analogous processes, the mechanism of which may also be similar.

The step following that of (2) is represented by (3). The membrane is delaminated from the surface border of the cortex and raised under the action of osmotic forces. In the eggs of Echinocardium submitted to treatment with sea-water – serum mixture, even the raised membrane very often still adheres to the border of the cortex by means of more or less developed strands which may later disintegrate.

Such strands are schematically represented in (3). The further development of the granular membrane needs no comment in addition to the above description.

The so-called vitelline membrane of the unfertilized egg is not identical, as often assumed, with the fertilization membrane. It forms only a part of the latter. In certain circumstances, the cortical granules are not incorporated into the membrane. Under these conditions, a thin membrane results which has a low double refraction and may be identical with the vitelline membrane.

The description given above of the fate of the cortical granules is at variance with the ideas entertained by Moser[5] concerning their role in the activation.

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[3] Hendee, Ester C., Papers from Tortugas Lab., Carnegie Inst. Pub., **27**, 101 (1931).
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[5] Moser, F., *J. Exp. Zool.*, **80**, 423 and 442 (1939).
[6] Cf. Runnström, Tiselius and Lindvall, NATURE, **153**, 285 (1944).
[7] Just, E. E., *Biol. Bull.*, **36**, 1 (1939).

Water Contents of Last-stage Larvæ, Pupæ, and Adults of the Meal Moth

ACCORDING to Speicher[1], larvæ and pupæ of the meal moth, *Ephestia kuehniella* Zeller, an important pest in meal stores, maintain a constant percentage of free water, independent of the relative humidity of the environment.

In contrast to Speicher's results, our observations show that migrating larvæ of Ephestia, which have been reared at low relative humidities, have a much lower average water content than larvæ kept at high humidities, although the water contents show considerable fluctuation.

On the other hand, water contents of pupæ of all ages show a practically steady average figure, which is independent of the relative humidity in which the insects were reared. This figure (see accompanying table), which agrees very well with Speicher's value, lies between the average percentage water contents of larvæ reared at 30 per cent and 70 per cent relative humidity respectively.

	Average water content as % of body weight	
	30% relative humidity	70% relative humidity
Migrating larvæ	57·3	73·5
Pupæ	65·4	66·4
Adults	65·4	66·3

The average water content of adults is practically the same as that of pupæ, and again appears to be independent of the humidity of the environment.

It is generally held that the water content in various instars of insect development can be regulated by the retention of metabolic water[2]. It seems, however, that Ephestia larvæ cannot compensate entirely for the increased rate of evaporation of water at low relative humidities.

When larvæ reared at low relative humidities are preparing to pupate, a more efficient mechanism of regulation comes into operation, so that the water contents of the resulting pupæ are almost identical with those reared at high humidities. The average weight of these pupæ developing at low humidities (30 per cent relative humidity), however, is approximately only 80 per cent of those reared under standard conditions (70 per cent relative humidity). It may be that the regulatory process involves the oxidation of a greater weight of reserve substances during the prepupal stage of those individuals reared in the drier environment.

Low environmental humidity definitely increases the duration of larval development (fifty days at 30 per cent relative humidity, as compared with thirty-three days at 70 per cent relative humidity), but the length of the pupal instar is only slightly affected.

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[1] *Proc. Pennsylvania Acad. Sci.*, **5**, 79 (1931).
[2] Wigglesworth, V. B., "Principles of Insect Physiology", 354 (London, 1939).

New Interference Phenomena with Newton's Rings

SOME striking new interference phenomena have been found with Newton's rings by using multiple-beam interference instead of the usual two beams. The rings, formed between a convex lens and a flat piece of glass, are modified profoundly by the employment of multiple beams. The two surfaces in contact are coated (by evaporation *in vacuo*) with high reflecting coefficient transparent silverings, the reflecting coefficient exceeding 0·85 for the green mercury line. The resulting multiple beams lead to the production of fringes which are characterized by their remarkable sharpness. The fringes in transmission are fine narrow brilliant rings on a broad dark background, and in reflexion can be seen a complementary system of fine dark 'absorption' fringes on a broad bright background.

Normal Incidence. Typical transmission rings (green mercury) with light incident normally on the interference faces are shown in Fig. 1. The sharpness is unique. It is necessary to restrict the incident light to a single angle of incidence by employing a small source at the focus of a lens in order to achieve the best definition. Comparison with the ordinary classical two-beam rings reveals the superiority of the multiple-beam fringes in the following particulars:

(1) They are much more intense.

(2) They are so sharp that very high precision can be attained. A change of 1/100 of an order can readily be *accurately* measured. This corresponds to a displacement of only 25 angstroms between the optical components. A great increase in precision is thus now available in all the numerous metrological applications of Newton's rings.

(3) The fringes are so inherently sharp that fine-scale surface defects and irregularities on the glass surfaces are rendered as detail in the fringes. For the reproduction shown as Fig. 1, the flat component was a simple piece of glass, and all the local

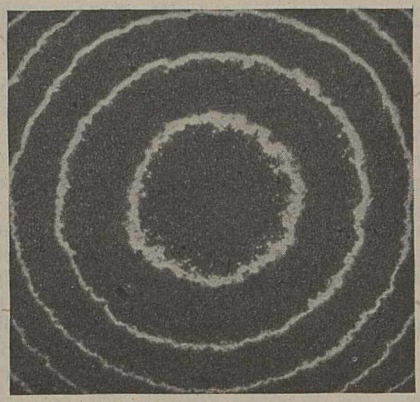


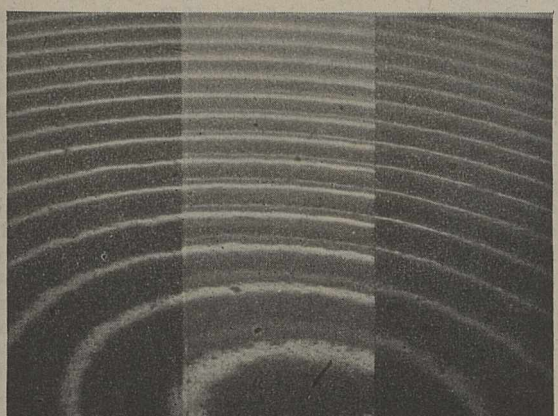
Fig. 1. NEWTON'S RINGS WITH MULTIPLE BEAM INTERFERENCE.

irregularities are clearly shown by the irregularities of fringes.

(4) By matching the curved component against a high-grade optical flat, the perfection of figure of the lens surface is revealed, with very great sensitivity. This effectively extends to curved surfaces the existing multiple-beam Fizeau test, used to-day only for flat surfaces.

Non-normal Incidence. New interference phenomena appear when the angle of incidence is other than normal. The fringes are no longer located in the film but lie on focal curves, one half of the ring system being situated before and the other half behind the interference film.

The fringes become double ; the separation between the two components growing steadily with increasing incidence. One component moves *out* towards the next higher order, becoming progressively *weaker* and also *sharper*. These two components are plane polarized, mutually perpendicularly. The phenomena are shown clearly by Fig. 2, which refers to an incidence of 60°. Fig. 2*b* shows the doubling, with no Nicol prism in the beam. In Fig. 2*a* a Nicol has been interposed to pass the beam with the magnetic vector perpendicular to the plane of incidence ; and in Fig. 2*c* the Nicol has been set to pass the parallel component. Owing to the peculiar focal properties of the non-normal fringes, only the fifth and sixth fringes are in focus in this reproduction.



a *b* *c*

Fig. 2. DOUBLING DUE TO DIFFERENTIAL PHASE CHANGE AT REFLEXION. (*a*) MAGNETIC VECTOR PERPENDICULAR TO PLANE OF INCIDENCE ; (*b*) NO NICOL PRISM ; (*c*) MAGNETIC VECTOR PARALLEL TO PLANE OF INCIDENCE.

The cause of the doubling is the existence of a differential phase change at reflexion at the silver surfaces. The phase change is different for the mutually perpendicular directions of vibration of the light. This differential effect has been measured over the range of incidence 0–80°. To the first order, the observations closely confirm the predictions of classical electromagnetic theory. Up to an incidence of 60° the experimental curve runs closely parallel to the theoretical curve, but is displaced upwards by a quite small, but real, amount, 0·007 λ. The observations reveal a marked, but small, inflexion at 63°, not predicted by theory, which is probably incomplete as to finer detail.

The remarkable sharpness of the parallel vector (see fifth and sixth fringes) is due to the higher effective Fresnel reflecting coefficient for this vector. It can be demonstrated that this parallel vector is rapidly absorbed with increasing incidence, and the rate has been determined. It follows from this that an evaporated silver film, when used to transmit light incident at high angles of incidence, should act as a polarizer (partial) in a manner similar to that which makes tourmaline act as a polarizer by differential absorption. This interesting property has been shown to exist, and can be very easily demonstrated.

The same characteristic fringe-doubling due to the differential phase change at reflexion at the silver has been found with small-gap Fabry-Perot interferometers, with the necessary modification that the parallel vector moves *inwards*, to the region of higher order of interference. For gaps of less than 1 mm., the differential doubling can lead to an appreciable loss in resolution, if the incident light is not polarized to compensate for this.

Full experimental details, together with an analysis of the phenomena very briefly surveyed here, have been communicated elsewhere.

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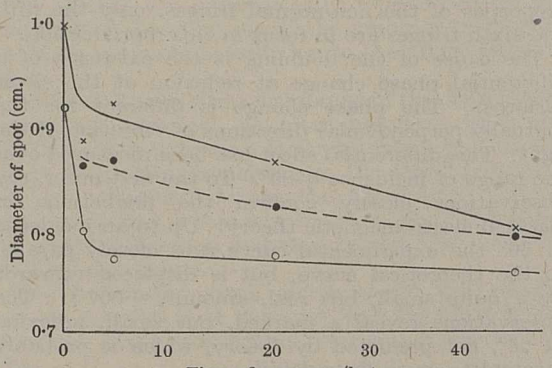
Influence of an Adsorbed (Inner) Layer on the Cohesion of a Solid

IN NATURE of January 22, Benedicks and Sederholm, under the above title, showed that the exposure to air of freshly cut surfaces of paraffin, lead and tin resulted in a lessened cohesion when two plane surfaces of the solid in question are brought into contact. By measuring the cohesion after different periods of exposure to the air, it was shown that, in the case of tin for example, important changes took place during the first five minutes exposure of a freshly cut surface. These changes are attributed to the rapid formation of a thin adsorbed layer.

A similar effect has been observed with silver and with iron by another simple technique. When a drop of distilled water of volume 0·03 c.c. is allowed to fall a distance of 2 cm. from the jet of a burette on to a freshly cut surface of the metal fixed in a horizontal position, the diameter to which the drop spreads before coming to rest is governed to a certain extent by the length of time the metal surface has been exposed to air.



Curve I, × ; Curve II, ● ; Curve III, ○.

The effect of exposing freshly cut silver (Curve III) and freshly cut iron (Curve I) to air inside a desiccator containing calcium chloride is illustrated in the accompanying graph, which also shows (Curve II) that the air of the laboratory in which these experiments were carried out does not affect the freshly cut silver in the same manner as does the drier and purer air inside the desiccator. In these experiments the surfaces were freshly cut by means of the unused emery face of a piece of Hubert emery paper grade 1*M*, any residual emery powder being quickly rubbed off by a few strokes with a ball of dry cotton-wool.

The importance of the pre-exposure of a metal surface to air in connexion with its chemical behaviour was established some years ago by U. R. Evans[1].

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[1] Evans, U. R., "Metallic Corrosion Passivity and Protection".

Determination of Specific Heat of Metals

I HAVE recently discovered a simple and novel method for measuring the specific heat of metals having known temperature-resistance coefficients.

A current, of sufficient magnitude to heat a wire to its melting temperature in a short time (within, say, 5×10^{-2} sec.), is passed through the wire. Under these conditions, the losses from the wire are negligible. By recording oscillographically the current through, and potential across, the wire, one can determine at any instant the resistance of the wire, from which its temperature can be found, and the energy imparted to it. From a single test one can thus draw a curve connecting energy input with temperature rise, from which one can determine the specific heat at any temperature within the range of the test or the mean specific heat over any range of temperature.

Fuller details, together with test results, will be given in an E.R.A. report shortly.

The method might be applied to any electrical conductor the resistance of which varies with temperature, the temperature coefficient being known.

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Dipole Moments of Polyatomic Molecules

IN calculating the dipole moments of polyatomic molecules, it is assumed that the observed moment is vectorially composed of the moments of the various links or bonds. The bond moments so deduced have no simple relationship to the values calculated from the internuclear distances and the electronic charge. The valency angles calculated from them vary and do not agree with theoretical values or even those found by other methods; interactions of the bond moments have been postulated in order to produce agreement between the calculated and the observed values. There is no vector between the bonds connected by single links due to free rotation or uncoupling.

These and other difficulties in the interpretation of dipole moments of polyatomic compounds are simplified by the conception that the dipole action is due to the rotation of the needle-shaped dipole[1], and each bond affects the polarization with the components of the other bonds calculated along the connecting links. The moments of the bonds are uncoupled when connected by single links. In the case of rigid molecules, the bond moments are affected inductively by the components along the connecting links and then add up vectorially.

Thus, according to vectorial addition, the observed moment in a triatomic molecule *ABA* is (I) $R = m^2 + m^2 + 2mm \cos\theta$, where m is the *AB* bond moment and θ is the *ABA* angle and the molecule is polarized along *BR*, where the angle *ABR* is $\theta/2$. According to the new law, (II) $R = m + m \cos\theta$, and the direction is along each *BA*.

When the dipoles are separated by a single connecting link with the same angle, the observed moment according to the new law is (III) $R = m + m \cos\theta^2$. If one more additional link making the same angle is introduced, the resultant is $m + m \cos\theta^3$. If the link bonds have their own moments, the respective components have to be added, paying regard to the sign. When the two end bonds are dissimilar, the resultant is represented by the arithmetic mean of the values calculated in the direction of each bond, or by the rule of squares.

In water the bond moment OH is $\frac{1}{2}$ ionic or dipolar ($2{\cdot}5D$), which, using 105° as HOH angle, gives $1{\cdot}88$ as the dipole moment of the H_2O molecule (obs. $1{\cdot}87D$). The calculated value for hydrogen peroxide assuming the tetrahedral angle for H–O–O is $2{\cdot}22D$ (obs. $2{\cdot}14$). The C–O bond is $\frac{1}{3}$ ionic ($3{\cdot}5D$) in alcohols and acids and $\frac{1}{4}$ ionic ($1{\cdot}75D$) in ethers, which leads to $1{\cdot}68D$ for the dipole moment of all alcohols and $1{\cdot}13$ for all ethers. The dipole moments of substituted anisoles are also in full agreement with the calculated values. The C=O bond is $\frac{1}{2}$ ionic and the calculated bond moment $2{\cdot}98$ is observed in all ketones. The calculated dipole moment of acetic acid is $1{\cdot}76D$ (obs. $1{\cdot}71D$). The uncoupling of C=O and OH bonds takes place owing to free rotation along the link C–O. The dipole moment of ethylene dichloride is $1{\cdot}69 \times (1 - \cos\theta^2) = 1{\cdot}50D$ (obs. $1{\cdot}5D$ at 200°); of quinol dimethyl ether using COC angle 105°, found in dimethylether, is $1{\cdot}75\ (1 - \cos 75°^2) = 1{\cdot}64D$ (obs. $1{\cdot}67D$).

The law of component moments accounts quantitatively for the anomaly of flexible molecules, the ortho, meta, para moments in aromatic compounds, the substituted anisoles, the diphenyls and naphthalenes, etc., on the basis of the regular geometry of the

molecules and theoretical values of angles and bond moments. Details will be published elsewhere.

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[1] NATURE, 153, 222 (1944).

Solubilization of Dyes in Non-aqueous Solvents

THOUGH a large number of instances of solubilization of water-insoluble substances like dyes, hydrocarbons, etc., in aqueous solutions of detergents are known[1], very few definite cases of the same phenomena have been reported for non-aqueous systems. In a recent note, McBain[2], for the first time, has adduced qualitative evidence to show the existence of such solubilization by hydrocarbon-soluble soaps and detergents, and has very recently cited a few more instances[3].

I have, however, observed that such solubilization is of rather frequent occurrence in the behaviour of resins dissolved in non-aqueous solvents. A systematic study has been undertaken and the results will be reported later. The present note records the hitherto unnoticed strong solubilizing power of resins, and also to direct attention to some peculiarities in this process not noticed by McBain and co-workers[2]. Their "experimental procedure has been to take approximately 1% solutions of pure or commercial detergents as supplied by the makers and add solid dye. Solubilization is indicated by the almost immediate coloration of the liquid." There is, however, an underlying source of error in this process of indicating solubilization, owing to the fact that some dyes ordinarily regarded as insoluble dissolve in traces in hydrocarbons to give a colourless solution which develops colour in presence of the dissolved resin (solubilizer). A good example is rhodamine; this dissolves slightly in benzene or toluene to give a colourless solution, which becomes pink on dissolving even a fraction of one per cent resin in it. So it is always necessary to check against such 'false' solubilization by noting the effect of adding the solubilizer to the dye-saturated solvent. This and other peculiar cases of chromatic interactions between dyes and resins have been observed and are receiving closer study.

A few cases of true solubilization are now being reported. The resins used have been crystalline abietic acid (the chief constituent of American rosin), purified glycerol triabietate (the chief constituent of ester gum) and soft resin of shellac, in 0·5 per cent solution in toluene and benzene at room temperature. Increase of temperature has always been found to favour solubilization. So far, about fifty pure and commercial dyes have been tried, of which only about ten have shown true solubilization to a more or less extent as given in the following list, cases marked with an asterisk indicating a very strong effect: Ester gum solubilizes methyl violet*, phenoplastic blue *RB**, methylene blue, brilliant green, alkali blue, quinoline *A*, safranine, neutral violet and phenoplastic yellow 6*G*; abietic acid solubilizes monalite red 2*RS*, brilliant green, alkali blue and quinoline *A*; soft resin of shellac solubilizes methyl violet*, phenoplastic blue *RB** and brilliant green.

McBain[2] believes that non-aqueous solubilization, like its aqueous counterpart, is due to adsorption of the dyes on the micelles. We, however, find in this phenomena a manifestation of the already observed liquid-like behaviour of resins[4], which might perhaps be ultimately due to the strong association tendency of the resin molecules, leading to formation of association dimers and polymers with the dye molecules.

A detailed examination of the mechanism of the process is, however, postponed until more data are forthcoming.

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Dec. 14, 1942.
(Delayed in transit)

[1] Pickering, *J. Chem. Soc.*, **3**, 86 (1917). Lester Smith, *J. Phys. Chem.*, **36**, 1401, 1672, 2455 (1932). Hartley, "Wetting and Detergency", 153 (1937). McBain and Woo, *J. Amer. Chem. Soc.*, **60**, 223 (1938), etc.

[2] McBain, Merrill and Vinograd, *J. Amer. Chem. Soc.*, **62**, 2880 (1940).

[3] McBain and Merrill, *Ind. Eng. Chem.*, **34**, 915 (1942).

[4] Palit, *J. Ind. Chem. Soc.*, **19**, 253 (1942).

Reported Asymmetric Synthesis of Santonin

SOME time ago[1] Paranjape, Phalnikar, Bhide and Nargund reported a synthesis of santonin from optically inactive materials: they now[2] claim that their product was active, being almost entirely the natural (*l*-) isomer. They state that the activity originated in the methylation of a 2-formyl*cyclo*hexanone derivative, and that the crude methylation product from 2-formyl*cyclo*hexanone (I) itself had the large specific rotation of — 26·2° in chloroform. Although they did not isolate 2-methyl-2-formyl-*cyclo*hexanone (II), they claim that an optically active derivative was prepared in a state of purity.

Such an asymmetric synthesis from inactive materials violates no fundamental law and might theoretically be expected to occur once in about $(10^{10})^{20}$ trials.

Nevertheless, Paranjape *et al.* claim to have achieved the asymmetric synthesis repeatedly. As we were interested in the products for another reason, it seemed worth while to repeat one of these experiments.

Sen and Mondal[3] prepared (II), though not in a pure condition, and established its structure by hydrolysis to 2-methyl*cyclo*hexanone. We find that (II) may readily be purified by fractionation at low pressure, forming a colourless oil of camphoraceous odour, b.p. 47°/0·05 mm., n_D^{18} 1·4683 (Found: C, 68·2, 68·4; H, 8·6, 8·4. $C_8H_{12}O_2$ requires C, 68·6; H, 8·6 per cent); the hydrolysis to methyl*cyclo*hexanone was confirmed. Neither the crude methylation product from (I) nor pure (II) showed any optical activity whatsoever.

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[1] *Current Science*, 12, 150 (1943).

[2] NATURE, **153**, 141 (1944).

[3] *J. Ind. Chem. Soc.*, **5**, 609 (1928).

RESEARCH ITEMS

Duration of Immunization against Diphtheria

H. Lyndhurst Duke and W. B. Stott (*Brit. Med. J.*, 710; Dec. 4, 1943) have published a paper of interest to all who have followed the Ministry of Health's advice that children—and especially children under five—should be immunized against diphtheria. They have studied the duration of artificial immunity to diphtheria in the Cuckfield and Burgess Hill areas, which have a child population of 9,600 children aged 1–15 years, 95 per cent of whom have been immunized as a result of a campaign started in 1936 by Dr. Stott. A large number of children under five were immunized. Material was therefore available for the study of the duration of the immunity, and more than 3,000 children were tested by the Schick test 2–6 years after immunization. The authors found that the number of children who lost their immunity rose steadily as time went on; after two years 4 per cent, and after six years 18 per cent had lost it. They conclude that it is important to test children some two years after the completion of the immunization. Boys and girls differ little in their response to the antigen. In great cities some 50–70 per cent of children may become naturally negative to the Schick test, but in rural areas natural Schick-negatives may be few, and in the area studied there was no evidence among children under five that such natural immunization had developed. Discussing the question of diphtheria carriers, the authors state their view that, year by year, as the campaign for immunization against diphtheria goes on, a large body of potential carriers is being formed, and that this has probably already built up the natural or artificially acquired level of immunity and acts as a buffer against large-scale introduction of new sources of the infection. It is important to remember that artificial immunization protects against the toxin which causes the symptoms, but not against the bacillus.

Gut of Nebaliacea

A COMPARISON of the structure of the gut of three species of the Nebaliacea, *Nebalia bipes* (Fabricius), *Nebaliella extrema* (f. Thiele) and *Nebaliopsis typica* (Sars) brings out some significant facts. Miss H. G. Q. Rowett (Discovery Reports, 23, 1–18; Cambridge: at the University Press, 1943; 3*s.* net) has subjected these to a searching inquiry and shows how well adapted each one is to its mode of feeding. Nebaliella and Nebaliopsis were obtained from the "Discovery" collections and are compared with *Nebalia bipes* from British shores. *Nebalia bipes*, the common British shore-living species, has been studied alive as well as in sections. It is a filter feeder, as Cannon (1927) has already shown. Its feeding mechanisms enable it to deal with larger particles as well as with the usual incoming flow of small matter in the zone. While *Nebalia bipes* lives usually above the mud just beneath or among pieces of seaweed, shells and stones, *Nebaliella extrema*, also a mud-dweller, is more a true burrower and feeds indiscriminately on the mud. Owing to the lower value of the food, the gut is adapted to deal more rapidly with much food. *Nebaliopsis typica* is specially interesting, for its gut is much specialized. Living at great depths in the open ocean, its surroundings are very different from the other species studied. There is good reason to believe that it feeds on eggs. A large digestive sac has been developed as a store chamber, meals probably fluctuating in abundance, and the lumen of the intestine has been reduced to ensure that nothing escapes thorough digestion. The fore gut is adapted to the puncturing and sucking of the eggs, and the mandibles to holding them in position during these processes. In this connexion it is interesting that the adaptations of the gut are very similar to those of the nudibranch *Calma glaucoides* of British coasts, which feeds on the eggs and embryos of small shore fishes. Special attention has been given to the musculature of the gut in all three forms. The plan is simple and constant, the changes being chiefly associated with the structure of the chitinous parts, and these in turn may be correlated with the habits of the species. The work is carefully illustrated with well executed text-figures.

Classification of Lamellibranchiata

BASED on a study of the ciliary mechanisms of the gills of the Lamellibranchiata, Daphne Atkins proposed a classification of the group. One of the divisions was termed the Microciliobranchia, and the author has now continued her investigations into the musculature of the gills of this section of the Lamellibranchs (*Quart. J. Micro. Sci.*, 84; 1943). The gill muscles serve several purposes; slight contraction removes obnoxious particles and opens and closes the grooves; more violent contraction not only reduces the size of the gills but also obliterates the interfilamentar and interlamellar spaces, and so reduces the possibility of injury to these delicate structures when the valves are violently closed. The major muscles of the gill axes are arranged in two groups, longitudinal and transverse. The former are in two sets, but as both are inserted into the shell they are able to act as retractors of the gills. The transverse muscles are also in two sets, one above and one below the chitinous support above the axial food groove, and by their action separate or bring together the demibranchs. In addition to these axial muscles there are also series in the demibranchs themselves.

Photoperiodism in the Potato

THE Imperial Bureau of Plant Breeding and Genetics at Cambridge has recently issued a technical communication by C. M. Driver and J. G. Hawkes on "Photoperiodism in the Potato" (Pp. 36. 2*s.* 6*d.*). In Part 1 of the bulletin, C. M. Driver reviews the experimental methods of a number of workers since Garner and Allard's classical investigations in 1920. A discussion then follows on the effect of long- and short-day periods upon vegetative growth, flowering and seed production, stolon and tuber formation and maturity. Potatoes differ in their response to day-length and it is evidently an inherited factor. Some South American species do not form tubers under long-day conditions, while others form them equally well under a range of photoperiods. Temperature has a modifying effect upon the response of the plants to length of day, a high temperature generally being antagonistic to tuber production, while a very low temperature may encourage varieties to form tubers under longer photoperiods than usual. Part 2, by J. G. Hawkes, describes experimental work carried out at Cambridge on the reaction to long and short days of a number of South American potatoes obtained from the Empire Collection. Some 75 clones from eight species were tested and assessed on tuber weight, tuber number, stolon production, time of maturing, height of plants, and flowering. It seems

that flowering in the potato may be dependent on the quantity of light received rather than on the actual length of day, and it is tentatively suggested that the photoperiodic mechanism may apply only to the dominant method of reproduction—in this case, to tuber formation.

Inheritance of a Mutation in Wheat Rust

T. Johnson and Margaret Newton have described the mode of inheritance of a mutant in *Puccinia graminis Tritici* Eriks. and Henn. (*Canad. J. Res.*, 21, C 205; 1943). The mutant is characterized by the production of white pustules on barberry owing to marked destruction of the chlorophyll in the infected area. The inheritance of this is independent of sex or physiological race. The original isolate produced approximately equal numbers of white and normal pustules, and crosses with other races showed that diploidization of the mycelium of normal pustules with spermatia from white pustules initiated races that also produced approximately equal numbers of white and normal pustules. Normal × normal crosses produced normal pustules, whereas white × white were sterile. Uredospores arose only occasionally in white pustules and then by diploidization by spermatia or mycelium from normal pustules.

Meiosis in the Striped Hamster

G. PONTECORVO (*Proc. Roy. Soc. Edin.*, 62, 32; 1943) has compared the meiotic behaviour of the striped hamster with that of the golden hamster previously examined by Koller. The striped hamster has $2n = 24$ chromosomes, a remarkably low number among Mammalia. During mitosis the heteromorphic sex chromosome pair can be distinguished easily since the differential segment is apparent; in the golden hamster, that cannot be found during mitosis. During mitosis, nucleoli are to be found in the striped hamster, but the golden hamster has none. These and other facts suggest that the nucleic acid metabolism is lower in the golden than in the striped hamster. The author makes the interesting suggestion that euchromatin and heterochromatin are similar in containing genes, but that the genes of the euchromatin are specifically distinct from one another and therefore metabolize nucleic acid at different rates. The heterochromatin, on the other hand, contains genes which are closely similar to one another or even replications. One block of heterochromatin may contain different genes from any other block. Hence the nucleic acid cycle is specific for this block. Further, the absence of many sex-linked genes in Mammalia, ever-sporting characters in Drosophila, the rarity of recognizable genes in heterochromatin in an evolution of the sex chromosome, could all be related to this hypothesis.

Transmission-Line Problems and the Impedance Circle Diagram

Willis Jackson and L. G. H. Huxley, in a paper read recently in London before the Institution of Electrical Engineers, point out that in modern microwave technique, transmission lines find wide application both for the interconnexion of component pieces of equipment, such as oscillators and receivers and aerial systems, and as inductive and capacitive circuit elements within these pieces of equipment. In the former they are normally several wave-lengths long, but in the latter only fractions of a wave-length. The analysis of their behaviour has been greatly facilitated by the development of a circle diagram technique, the theory and application of which are discussed. This is followed by a discussion of the fundamental principles underlying the transmission-line equations on which this technique is based, and of the meaning to be attached to the word 'impedance' at very high frequencies in respect of terminating attachments to lengths of transmission line. In particular, attention is given to the physical possibility of producing a non-reflecting termination, on one aspect of which there appears to have been widespread misunderstanding.

Variation of Latitude at Greenwich, 1936–40

SIR HAROLD S. JONES, the Astronomer Royal, has communicated a paper (*Mon. Not. Roy. Astro. Soc.*, 103, 5; 1943) on this subject, which discusses the results obtained with the Cookson floating zenith telescope, Royal Observatory, Greenwich, since the introduction of the new programme in 1936. In that year the instrument was moved from the courtyard of the Royal Observatory to the Christie Enclosure, and the new programme consisted of twenty-four groups of pairs of stars, each group extending over about one hour of R.A. Three groups are observed nightly, centred at Greenwich mean midnight, and hence each group can be directly connected with groups on either side of it, differing by 2^h R.A. at the most. Observations were interrupted in the autumn of 1940, and in addition, slight damage to the instrument necessitated dismantling and storing the objective and telescope. The available material up to the autumn of 1940 has been used to determine the variation of latitude over the four years 1936–40. The group corrections, to be added to observed-tabular Z.D. north, are given, and these are in close agreement with those derived by Hulme for the years 1936–38. They contain the periodic term in R.A. $+ 0{\cdot}118'' \sin \alpha + 0{\cdot}012'' \cos \alpha$. Values of the latitude variation, applicable to N.P.D.s, are given for each of the years 1936–40 inclusive.

Interstellar Calcium Clouds

REMARKABLE spectrograms showing complicated structure in the interstellar calcium lines *H* and *K* have recently been published (*Astrophys. J.*, 97, 105; 1943). The spectra of fifty early-type stars have been studied with high dispersion (2·9 A./mm.) at the coudé focus of the 100-in. telescope at Mt. Wilson. More than 80 per cent of the stars show complex lines with up to five components. Various regions of the sky show different complexities of structure: towards Perseus and Scorpius single lines are frequent, with at most one satellite; whereas in the Orion, Sagittarius, Cygnus and Lacerta regions intricate structures are the rule. Stars close together in the sky exhibit lines of much the same structure. The evidence strongly suggests that interstellar calcium occurs to a great extent in discrete clouds, each with its own small peculiar motion but with little internal turbulence. Many of the spectrograms show also the additional narrow interstellar lines, atomic and molecular, discovered in recent years. Lines of Fe I seem to occur only in regions showing *H* and *K* strongly, whereas the diatomic molecules CN, CH and CH^+ may appear where calcium is not particularly abundant. The wave-length shifts given by these other lines show that they originate in one or other of the calcium clouds producing the *H* and *K* lines.

ANGLO-AMERICAN COLLABORATION IN THE CARIBBEAN REGION

THE report of the Anglo-American Caribbean Commission to the Governments of the United States and Great Britain for the years 1942–43, which has now been published*, leaves no room for doubt as to the successful start of this first attempt by Britain and the United States at joint control, and at the same time puts into a proper perspective that excessive concern regarding national sovereignty displayed in the statement issued in Washington with the joint communiqué announcing the creation of the Commission. The report itself is in three chapters, discussing in succession the organization of the Commission and the immediate and the long-term aspects of the Commission's programme, but is supported by the text of the joint communiqué of March 9, 1942, reports of the four meetings of the Commission of the Supply Officers' Conference, Jamaica, May 15–18, 1942, and of the Nutrition, Agriculture, Fisheries and Forestry Meeting in August 1943, which led to the creation of the Caribbean Research Council as an advisory body to the Commission. The objectives of this Council will be to survey needs, determine what research has been done, arrange for dissemination and exchange of the results of research, provide for conferences between research workers or extension workers, and make recommendations for further research and co-operation.

The organization thus far established consists of three interrelated units. First is the Commission itself, consisting of two sections of three members each, appointed by their respective Governments, and charged with the duty of helping the territories and colonies in the Caribbean in charting a system of co-operation which will reinforce their economy and society and give them added strength. The British section is closely affiliated with the Colonial Office in London, and with the Development and Welfare Organization in the West Indies. Second is the Caribbean Research Council, which provides the technical and scientific advice required to promote scientific, technical, social and economic advance, and is itself assisted by sectional committees, the first of which covers nutrition, agriculture, fisheries and forestry. The third unit of the organization is a regular system of West Indian Conferences, which is being inaugurated to provide for local consultation. This unit will be a standing body, meeting as and when required, with two delegates from each territory or group in the Caribbean area.

Following a series of meetings of the Commission and conferences in the West Indies, Washington and London, basic policies have been agreed upon in principle by an exchange of notes between the two Governments. The view is taken that the economic problems of the Caribbean should be regarded as regional rather than local. Generally speaking, a single-crop economy in the West Indies is undesirable. Mixed farming and animal husbandry should be encouraged everywhere, but a closed economic system should not be constituted. Inter-island trade should be encouraged throughout the entire Caribbean region. Advantage should be taken of fishing grounds in, and adjacent to, the Caribbean, and local fisheries with facilities for storage and distribution should be developed and organized. A greater vocational bias should be introduced into the educational system, and in addition to wide improvement of housing and sanitary conditions and an extensive school building programme, the inadequate transport to and within the Caribbean requires improvement. This will need co-ordination and planning on a broad scale. As an immediate and effective approach to the nutrition problem the Commission will investigate the provision of midday meals for children at school. The possibilities of industrial development, though limited, should not be overlooked.

On the immediate aspects of the Commission's programme, the report refers to the action taken to meet the food crisis which developed in the Caribbean in 1942. The Commission was responsible for establishing an organization for the bulk purchase of imported food necessities and assisted in developing a system of inter-island distribution. The measures taken led to a substantial increase in local food production and also to an alteration in the established eating habits of the peoples of the area. The fishery industries have received special attention, and the United States section of the Commission made a study of the sugar situation at the end of the summer of 1942 and formulated proposals which have been taken into account by the United States and the British Government in determining their policy with regard to the 1943 crop.

One outcome of the Conference of Supply Officers was the establishment of an Emergency Land Water Highway to provide a safe transport service from the mainland of the United States to Puerto Rico; in view of the improved situation with regard to submarine warfare, the service over the Hispaniole Highway and the maintenance of stockpiles were suspended in August 1943. The Conference also approved a recommendation that a single supply organization should be created for all the British Colonies, and the British Colonies Supply Mission has been established in Washington.

The long-range aspects of the Commission's programme demand long-term planning, and the basic problems are grouped roughly under the following headings: (1) conservation and utilization of natural resources; (2) development of systems of agriculture based upon improved efficiency; (3) development and maintenance of trade and communications among the Caribbean territories and colonies and with non-Caribbean areas; (4) provision of adequate housing and the improvement of public health; (5) full use of man-power in productive employment and the improvement of welfare among rural communities; and (6) broadening of education to include vocational instruction, the strengthening of public morale, and the promotion of 'self-help' and community co-operation.

The initial fishery survey is being followed up by a more detailed study in the south-eastern Caribbean, and commercial fishery research is being started. Special committees have already been formed under the Caribbean Research Council to report on land tenure and on the measures necessary to maintain diversified production. Arrangements have been made for the full collaboration of forestry services throughout the Caribbean with the United States Federal Forestry Research Institute in Puerto Rico, and the Research Council will assist in co-ordinating studies on forestry problems in the Caribbean and comparable areas. The Commission is giving attention to

* Report of the Anglo-American Caribbean Commission to the Governments of the United States and Great Britain for the Years 1942–1943. Pp. xi+94. (Washington: Anglo-American Caribbean Commission, 810 18th Street, North-West. London: Crown Agents for the Colonies, 1943.) 3d.

the removal of restraints to trade and travel between the British and the United States Virgin Islands. It has given full support to the work of the Federal Works Agency in Puerto Rico and the Virgin Islands, as well as to the programme of works projects drawn up by the Development and Welfare Organization for the British West Indies. At a conference in Washington in July 1943, it was decided that the Commission offered an effective medium for co-ordinating sanitation and health problems in the area, and a consultative committee was eventually formed for this purpose. Quarantine matters have received special attention, including the drafting of model quarantine legislation. This received detailed consideration at a Quarantine Conference in November 1943 under the auspices of the British West Indies Development and Welfare Organization in co-operation with the Commission. The primary objective of this Conference was to consider the adoption of uniform quarantine procedure throughout the British Caribbean Colonies in regard to maritime traffic, air navigation, and the adoption of model quarantine legislation.

Scientific workers will find particular interest in the detailed programme of research required on soil, water and forest conservation appended to the report on nutrition, agriculture, fisheries and agriculture which led to the formation of the Caribbean Research Council. In addition, the report itself includes detailed proposals for investigations on diet and health, food supply and nutrition, nutrition and public health, on animal husbandry, for which a long-range research programme is formulated, on fisheries, food processing, storage and marketing. Special stress is laid on research in animal husbandry, which has been wholly inadequate in the Caribbean; it is believed that no other investment would yield greater returns in terms of nutritional well-being than measures to increase the proportion of animal proteins in the diet, through improved and adapted animal husbandry and a stable and more efficient agriculture.

ROYAL COLLEGE OF SURGEONS

SCIENTIFIC REPORT

THE Scientific Report of the Royal College of Surgeons of England for the year 1942–43 gives the welcome news that no further specimens, Hunterian or College, were destroyed or suffered major damage during that year. The general condition of the specimens is satisfactory, but the task of looking after a large collection which is dispersed among various centres, some of which do not provide adequate or suitable accommodation, must be an arduous one, especially when so many of the staff are serving with the Forces. The need for better and more convenient accommodation for the specimens, with working room and technical facilities, is still urgent.

The report gives a list, covering six pages, of additions to the Museum, and an account of the research going on in the Bernhard Baron Research Laboratories under the direction of Prof. J. Beattie. During 1941–42 it was shown that plasma proteins can be removed rapidly from the blood-stream and can also enter the blood-stream very rapidly in considerable quantities. It was found that the rate of entry was so rapid that it could not be due to the synthesis of protein from amino-acids in the liver, and that plasma protein could be mobilized from tissues other than the liver. Since the end of 1942, the problem of increasing the rate of protein synthesis by the liver has been studied. Casein digests suitable for intravenous or subcutaneous administration are now being tried, with the object of increasing the rate of protein synthesis in the body. It is considered that such digests might be valuable for the treatment of burns, severe infections and fractures, in all of which conditions the loss of plasma proteins is considerable. The use of digests and pure amino-acids for the prevention of severe liver damage is also being studied.

In 1943 a study of toxic hepatitis was begun with the co-operation of the British and American Army authorities. It has been found possible to prevent the liver damage which occurs in syphilitic patients receiving arsenical treatment, and to reduce the period spent in hospital from 27 to 11 days and the convalescent period from three months to ten days.

Nerve injuries are being studied by a Leverhulme Research Scholar at Oxford and, at the suggestion of the Ministry of Health, a study was undertaken of raw materials which might take the place of absorbable catgut for sutures. A suitable raw material has been found, and this has passed laboratory and clinical trials. All the staff of the Buckston Browne Research Farm joined the Forces at the outbreak of the War, and the main laboratories there were taken over by the Emergency Public Health Service.

CLASSIFICATION OF ANTS

THE naming of the different species of ants and their classification into genera, tribes, subfamilies, etc., is but an artifice, a mere convenience, although an all-important one if we are to dispose of our knowledge of myrmecology to the best advantage. In fact, to-day, a knowledge of formicid nomenclature is essential to anyone wishing to make a reasonable acquaintance with myrmecology.

It is perhaps strange, then, that although some five thousand species of ants have been described and given names since the time of Linnæus, and these five thousand species distributed among approximately four hundred genera and four-score tribes belonging to eight sub-families, no myrmecologist has during the last thirty years published even a complete list of the ant genera, let alone any more comprehensive guide to formicid nomenclature. It is true that Emery in the "Genera Insectorum" (1910–25) covered the whole family, but although he provides the skeleton for the future taxonomic treatment of the group, it is sadly incomplete and in many cases out of date and inaccurate.

Emery lists only two hundred and sixty genera and fifty-three tribes, which he places in five subfamilies (*Dorylinæ* Leach, *Ponerinæ* Mayr, *Myrmicinæ* Lepeltier, *Dolichoderinæ* Forel and *Formicinæ* Forel) as against the modern eight; the three new subfamilies being the *Cerapachyinæ* Wheeler (previously a tribe *Cerapachii* Forel and later a section *Prodorylinæ* Emery of the *Ponerinæ* Mayr.), the *Leptanillinæ* (Emery) Wheeler, containing the solitary genus Leptanilla Emery earlier attributed to the *Dorylinæ* Leach, and the *Pseudomyrminæ* (Emery) Wheeler, previously considered as a tribe of the *Myrmicinæ* Lepeltier. Furthermore, the "Genera Insectorum" is scarce and difficult to obtain except at universities

and large institutions, where, of course, it may only be borrowed.

Wheeler's lists of the genera and their types (1911 and 1913) were therefore of great value, although incomplete and even more inaccurate than Emery's in the "Genera Insectorum".

The recent publication of Donisthorpe's "List of the Type species of the Genera and Subgenera of the Formicidae" (*Ann. and Mag. Nat. Hist.*, ii, **10**, 617, 649, 721; 1943) is therefore an event of considerable importance. For the first time there is an authoritative, complete (so far as is known) and easily obtainable list of the genera and subgenera of ants. Furthermore the tribe, subfamily and also, where it occurs, synonomy of each of the genera listed are given. The type species are listed in each case, together with the type locality.

It is difficult to review such a list without entering into detail which would be out of place here, but which I hope to discuss elsewhere. A few points may, however, be mentioned. The use of the generic name Lasius Fabr., a synonym for Acanthomyops Mayr (five species of which are found in Great Britain), perpetuated by Wheeler and Emery, should now cease for good and all. Fabricius's name sinks on account of Jurine's earlier one. Ruzsby's subgenus Lasius (s.g. of Lasius Fabr. Acanthomyops Mayr.) also sinks to Morrice and Durrant's Donisthorpea. It is nice to see Crematogaster Lund for once spelt correctly and not as in Wheeler's "Ants" (1910) and Forel's "Social World of the Ants" (London, 1927) with an 's', namely, Cremastogaster, which is meaningless. Emery's mis-spelling of Chtonolasius Ruzsby (copied by Donisthorpe in his "British Ants", 1927) has also been corrected.

The function of nomenclature is to aid and simplify the work of the zoologist, not to confuse him and make his task more complex. It is a mechanism for handling the data appertaining to, and not a fundamental part of, biology, and as such the taxonomy of a group should be well-ordered, comprehensible and easily accessible. Donisthorpe is therefore to be congratulated on this attempt to produce order out of chaos and to make accessible that which has been beyond the reach of all but the experienced myrmecologist—in fact, Donisthorpe himself and less than half a dozen others in the world.

B. D. WRAGGE MORLEY.

PELAGIC FORAMINIFERA

WE owe much of our recent knowledge of the biology of the Foraminifera to Dr. E. H. Myers. His new publication* is a peculiarly beautiful example of his work, embracing the complete life-cycle of Tretomphalus and its activities observed both in Nature and in cultures. The life-cycle includes an orderly succession of sexual and asexual generations in which two distinct types of individuals and three types of tests are involved. Typically benthonic microspheric (asexual) and megaspheric (sexual) individuals are produced, the latter becoming pelagic prior to the discharge of the gametes. The test of the pelagic phase has a globular terminal chamber, perforated by large pores, and contains a gas-filled float, the gametes passing out of the pores. The zygotes are formed by the fusion of gametes from different parents, the latter approaching one another and their amœboid pseudopodia anastomosing—an unusual occurrence in the Foraminifera. This association ensures the fertilization of a maximum number of gametes, which settle on the bottom and produce microspheric tests. So the life-cycle proceeds.

Tretomphalus is shown to be significant only as a convenient category in which to place the pelagic stage of species which are now included in either the genus Discorbis, family Rotaliidæ, or the genus Cymbaloporetta, family Cymbaloporidæ. Much confusion in nomenclature has been caused by the polymorphic nature of these tests, and this work should contribute largely to a more natural classification.

Observations on feeding show that swiftly moving organisms, such as nauplii, ciliates and veligers, are not captured, although these can be utilized as food when crushed and placed in the vicinity of the test. On the other hand, grazing on diatoms and other unicellular algæ on the walls of the dish is usual, and inclusions of these can be seen in sections. Similar sections of material from the sea show that the natural food is the microflora both from the water or on the substratum fixed on the surface where the animals live.

Interesting accounts are given of the formation and growth of the tests. Under optimum conditions in cultures maintained at 20° C., about forty-two days are required for an asexually produced individual to form a test consisting of 13–17 chambers.

The illustrations which accompany this paper, both photographs and drawings, are of great beauty and clarity, and special mention should be made of the photograph of dispersal of the juveniles and the disintegration of the empty test of the microspheric individual which produced them: also the figure of the life-cycle of *Tretomphalus bulloides*.

* Biology, Ecology and Morphogenesis of a Pelagic Foraminifer. By Earl H. Myers. Stanford University Publications. University Series. Volume IX. Number 1. Biological Sciences. Stanford University Press. 1943.

RECENT AMERICAN ARCHÆOLOGY

EUROPEAN archæologists are too often apt to forget that the prehistoric period continued in many parts of the world, America included, until about the day before yesterday. Moreover, just because the later time limit of the study is so recent, much more evidence can frequently be collected than in the case of the very remote cultures, and thus a picture in greater detail constructed. The fact, then, that Waldo R. Wedel's recent archæological investigations in Platte and Clay counties, Missouri (United States National Museum, Bull. 183), deal with finds which in western Europe would be classed as post-medieval in date, does not make them any less interesting or less important. The interest and importance of the ruins at Zimbabwe in Southern Rhodesia were not lessened when it was shown that their date was anything but prehistoric in our sense of the word.

Mr. Wedel is concerned with village sites and two kinds of burial mound. He suggests the presence in the area of two different cultures. One (the Renner village site is the type site) shows definite relationships with certain "Northern Elemental Hopewellian Manifestations" such as those found in the Illinois valley and south-western Wisconsin, the other (the Steed-Kisker site is the type station) recalls the Nebraska culture, characteristic of the Missouri River bluffs in eastern Nebraska and south-

western Iowa, being a local variant of the late Middle Mississippi culture. The stone-chambered burial mounds containing dolicocephalic remains are classed with the first-named culture, the earth mounds with the latter. Actually, at Steed-Kisker itself the dead were buried in graves and large earth mounds are absent. When contrasting the material culture from the two classes of sites, no very startling difference is observable, but there are distinctions noticeable in the pottery types, as well as in other classes of finds. An appendix on the types of human skeleton collected is written by T. Dale Stewart.

Once again we are dealing with local investigations on the more recent archæology of America. So much material having survived for this period in the New World, it is not yet time for a major work of synthesis, but volumes such as the one under review will be the source of information for future compilers of the history of the United States during the centuries immediately preceding the arrival of the Europeans.

M. C. BURKITT.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, March 13

SOCIETY OF CHEMICAL INDUSTRY (YORKSHIRE SECTION) (in the Chemistry Lecture Theatre of the University, Woodhouse Lane, Leeds), at 7 p.m.—Dr. T. H. Blakeley: "Graphical Methods of Treating Technical Problems".

ASSOCIATION OF AUSTRIAN ENGINEERS, CHEMISTS AND SCIENTIFIC WORKERS IN GREAT BRITAIN (at the Austrian Centre Swiss Cottage, 69 Eton Avenue, Hampstead, London, N.W.3), at 7.15 p.m.—Dr. K. Weissenberg: "Chemical Constitution and Physical Properties of Materials".

Tuesday, March 14

CHADWICK PUBLIC LECTURE (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 2.30 p.m.—Dr. S. A. Henry: "Medical Supervision in Industry in Peace and War".*

INSTITUTION OF CHEMICAL ENGINEERS (joint meeting with the CHEMICAL ENGINEERING GROUP) (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Mr. W. K. B. Marshall: "The Welded Joint in Non-Ferrous Chemical Plant".

PARLIAMENTARY AND SCIENTIFIC COMMITTEE (in Committee Room 14, House of Commons, London, S.W.1), at 3 p.m.—Discussion on "A Scientific Policy for British Agriculture, particularly in relation to Nutrition" (Speakers: Prof. F. L. Engledow, Prof. Miller and others).

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Prof. A. R. Todd, F.R.S.: "The Mode of Action of some Vitamins", 2.*

INSTITUTION OF CIVIL ENGINEERS (joint meeting with the INSTITUTION OF MECHANICAL ENGINEERS) (at Great George Street, Westminster, London, S.W.1), at 5.30 p.m.—Symposium on "Contractors' Plant".

Wednesday, March 15

INSTITUTE OF METALS (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 11 a.m.—Thirty-sixth Annual General Meeting; at 2.30 p.m.—Dr. W. Hume-Rothery, F.R.S.: "Modern Views on Alloys and their Possible Application".

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr. J. N. Dean: "Gutta Percha and Balata, with Particular Reference to their Use in Submarine Cable Manufacture".

SOCIETY OF CHEMICAL INDUSTRY (PLASTICS GROUP) (joint meeting with the PHYSICAL SOCIETY) (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 2.30 p.m.—Dr. W. T. Astbury, F.R.S.: "The X-Ray Examination of Plastics".

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 3 p.m.—Annual General Meeting. Prof. W. G. Fearnsides, F.R.S.: "The Practice of Geology" (Anniversary Address).

ROYAL INSTITUTE OF CHEMISTRY (at 30 Russell Square, London, W.C.1), at 3 p.m.—Annual General Meeting. Mr. P. A. Houseman: "Licorice—Putting a Weed to Work" (Streatfeild Memorial Lecture).

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, South Kensington, S.W.7), at 4.30 p.m.—Major H. C. Gunton: "Report on the Phenological Observations in the British Isles from December 1942 to November 1943".

INSTITUTION OF ELECTRICAL ENGINEERS (LONDON STUDENTS' SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 7 p.m.—Mr. H. W. H. Warren: "Electrical Engineering Research" (Student's Lecture).

Thursday, March 16

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 1.30 p.m.—Sir John Russell, F.R.S.: "Europe's Changing Peasantry".

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Dr. C. R. Harington, F.R.S.: "Newer Knowledge of the Biochemistry of the Thyroid Gland" (Ninth Pedler Lecture).

SOCIETY OF CHEMICAL INDUSTRY (AGRICULTURE GROUP) (joint meeting with the BIRMINGHAM SECTION) (at the Chamber of Commerce, New Street, Birmingham), at 2.30 p.m.—Mr. P. Parrish: "Our Fertilizer Industry; with Special Reference to Modern Methods of Manufacture of Calcium Superphosphates, Ammonium Sulphate and N.P.A. Granular Fertilizers".

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 3 p.m.—Prof. H. W. Turnbull, F.R.S.: "Recent Advances in the Theory of Forms".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. P. Schiller: "An Analysis of the Load on a Modern Electricity Supply System".

Friday, March 17

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5 p.m.—Mr. Howard Marryat: "Evolution of the Pocket Watch".*

INSTITUTION OF ELECTRICAL ENGINEERS (MEASUREMENTS SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. R. Dell: "Developments of Railway Signalling on London Transport".

INSTITUTION OF MECHANICAL ENGINEERS (in conjunction with the APPLIED MECHANICS GROUP) (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Symposium on "Some Modern Aids in the Investigation of the Behaviour of Materials, Mechanisms and Structures".

BRITISH ASSOCIATION OF CHEMISTS (NORTH-EAST SECTION) (in the Chemistry Lecture Theatre, King's College, Newcastle-upon-Tyne), at 6 p.m.—Dr. F. G. Mann: "Some Aspects of the Organic Chemistry of Phosphorus and Arsenic" (Tilden Lecture of the Chemical Society).

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (in the Lecture Theatre of the Mining Institute, Newcastle-upon-Tyne), at 6 p.m.—The late Dr. W. H. Hatfield, F.R.S., Mr. L. Rotherham and Miss E. M. A. Harvey: "Further Experiments on the Damping Capacity of Metals".

Saturday, March 18

BRITISH INSTITUTE OF RADIOLOGY (in the Reid-Knox Hall, 32 Welbeck Street, London, W.1), at 2.30 p.m.—Mr. W. J. Meredith and Dr. G. J. Neary: "The Production of Isodose Curves and the Calculation of Energy Absorption from Standard Depth Dose Data"; Mr. P. H. Flanders: "A Demonstration of an Optical Contour Finder".

SHEFFIELD METALLURGICAL ASSOCIATION (at 198 West Street, Sheffield), at 2.30 p.m.—Dr. H. M. Finniston and Mr. T. D. Fearnehough: "The Physical and Mechanical Properties of Segregates".

APPOINTMENTS VACANT

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

ELECTRICAL ENGINEER (location, Middle East)—The Ministry of Labour and National Service, Central (Technical and Scientific) Register, Advertising Section, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. D.767A) (March 15).

CHEMICAL ENGINEER, to assist in the design and testing of plant for the manufacture of various chemicals, mainly organic—The Ministry of Labour and National Service, Central (Technical and Scientific) Register, Advertising Section, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. C.2040.XA) (March 15).

TEACHER to teach mainly MECHANICAL DRAWING in the Junior Technical School, with some MATHEMATICS and/or WORKSHOP PRACTICE (wood or metal)—The Principal, County Technical College, Gainsborough, Lincs. (March 17).

ASSISTANT TO THE ADVISORY CHEMIST—The Chief Advisory Officer, Agricultural Advisory Department, The University, Manchester (March 18).

GRADUATE MISTRESS (MATHEMATICS) for Barrett Street Technical School, Oxford Street, London, W.1, and Maidenhead—The Education Officer, T.1, County Hall, Westminster Bridge, London, S.E.1 (March 18).

HEADMASTER OF THE PRE-APPRENTICESHIP COURSES FOR THE BUILDING TRADES recently established in Aberdeen—The Director of Education, Education Offices, Castle Street, Aberdeen (endorsed 'Pre-Apprenticeship School') (March 18).

PRINCIPAL—The Clerk to the Governors, Harper Adams Agricultural College, Newport, Shropshire (March 18).

PROFESSOR OF MECHANICAL ENGINEERING in the Benares Hindu University Engineering College—The Secretary, Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1 (March 18).

COMMISSIONS IN H.M. FORCES (a limited number) will be granted to candidates who are University-trained Biologists, preferably men with some experience of malaria or entomology—The Ministry of Labour and National Service, Central (Technical and Scientific) Register, Advertising Section, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. ONF.2057A) (March 18).

UNIVERSITY CHAIR OF ANATOMY tenable at St. Mary's Hospital Medical School—The Academic Registrar, University of London, c/o Richmond College, Richmond, Surrey (March 20).

TUTORS (2, men, preferably unmarried) at the Makerere College, Kampala, Uganda; Post 1, GEOGRAPHER to teach in New Arts Course, should be specially qualified on the Humanistic (i.e., Social and Economic) side of the subject; Post 2, CHEMIST qualified to teach both Organic and Inorganic and with a special interest in Biochemistry—The Secretary (IPR/CA), Board of Education, Belgrave Square, London, S.W.1, or The Secretary, Scottish Education Department (Branch Office), 29 St. Andrew Square, Edinburgh 2 (March 21).

CIVIL ENGINEERS by a firm of Contractors in the Near East—The Ministry of Labour and National Service, Central (Technical and Scientific) Register, Advertising Section, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. EA.803.XA) (March 22).

MUSEUM ASSISTANT (man or woman) IN THE DEPARTMENT OF ZOOLOGY—The Secretary, Bedford College for Women, Springfield, Sidgwick Avenue, Cambridge (March 22).

DEPUTY BOROUGH ELECTRICAL ENGINEER—The Borough Electrical Engineer, Electricity Works, Warrington (endorsed 'Application for Deputy Borough Electrical Engineer') (March 24).

TEACHER (man or woman) at the Cannock Chase Mining College, mainly for the daytime teaching of Soience—The Director (H), County Education Offices, Stafford (March 25).

READERSHIP IN MINERALOGY—The Registrar, University Registry, Oxford (April 8).

WAYNFLETE PROFESSORSHIP OF METAPHYSICAL PHILOSOPHY—The Registrar, University Registry, Oxford (April 13).

PROFESSORSHIP OF ENGINEERING SCIENCE—The Registrar, University Registry, Oxford (April 30).

CHAIR OF PHILOSOPHY at the University of the Witwatersrand, Johannesburg—Dr. William Cullen, 4 Broad Street Place, London, E.C.2 (May 1).

DIRECTOR OF THE INSTITUTE OF MEDICAL AND VETERINARY SCIENCE, Adelaide—The Agent-General and Trade Commissioner for South Australia, South Australia House, Marble Arch, London, W.1 (May 31).

CHAIR OF NATURAL PHILOSOPHY, United College, St. Andrews—The Secretary, The University, St. Andrews (June 15).

LECTURER IN MECHANICAL ENGINEERING at the Norwich City College and Art School—The Director of Education, City Hall, Norwich.

GRADUATE ASSISTANT to teach chiefly PHYSICS and MATHEMATICS in the Thomas Richards Technical Institute, Tredegar—The Director of Education, Higher Education Department, County Hall, Newport, Mon.

MATHEMATICS MISTRESSES (2) at the Jerusalem Girls' College, and a MATHEMATICS MISTRESS at the English High School, Haifa—The Secretary, Jerusalem and the East Mission, 8 St. Thomas Street, Winchester.

SENIOR LECTURER IN THE PHYSIOLOGY DEPARTMENT—The Secretary, University of Edinburgh, Summerhall, Edinburgh 9.

WOMAN GRADUATE to take charge of analysis of original material on food purchases and consumption and its presentation in statistical tables—Appointments Department, Ministry of Labour and National Service, Sardinia Street, London, W.C.2 (Quoting Reference No. Q.M.33).

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Ministry of Agriculture and Fisheries. Bulletin No. 127: Home Curing of Bacon and Hams; a Manual of Theory and Practice for Instructors and Others. Compiled by the Small Pig Keepers' Council. Pp. ii+57+4 plates. (London: H.M. Stationery Office.) 1*s.* 3*d.* net. [281

Institution of Electrical Engineers. Electricity Supply, Distribution and Installation: a Report to the Council from the Post-War Planning Committee. Pp. ii+26. (London: Institution of Electrical Engineers.) [301

Incorporated Association of Electric Power Companies. Memorandum wtih regard to the Electricity Supply Industry in Great Britain. Pp. 30. (London: Incorporated Association of Electric Power Companies.) [301

British Electrical and Allied Industries Research Association. Twenty-third Annual Report, October 1st, 1942 to September 30th, 1943. Pp. 130. (London: British Electrical and Allied Industries Research Association.) [12

Report of the London Chamber of Commerce on Scientific Industrial Research. Pp. 16. (London: London Chamber of Commerce.) [12

Occasional Publications on Scientific Horticulture. Nos. 1–3 (1939–42). Abridged edition, with Supplement. Pp. 100. (Sutton Bonington: Midland Agricultural College.) 4*s.* 3*d.* [32

Scientific Proceedings of the Royal Dublin Society. Vol. 23 (N.S.), No. 17: Ascorbic Acid, Part 2: Factors determining Stability in Aqueous Solution. By Einhart Kawerau and W. R. Fearon. Pp. 171–180. 1*s.* Vol. 23 (N.S.), No. 18: Ascorbic Acid, Part 3: The Ascorbic Acid Content of Fruits and Vegetables Grown in Fibre. By Einhart Kawerau. Pp. 181–196. 1*s.* 6*d.* (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd.) [72

Iron and Steel Institute. The Training of Metallurgists, with Special Reference to the Iron and Steel Industries. Pp. 32. (London: Iron and Steel Institute.) 2*s.* 6*d.* [72

Manchester Museum: University of Manchester. Report of the Museum Committee for the Year 1942–1943. Pp. 20. 6*d.* net. Museum Publications, New Series 2: New Greek Vases in the Manchester Museum. By Prof. T. B. L. Webster. Pp. 6+4 plates. 6*d.* (Manchester: Manchester Museum.) [72

Occupied Europe: German Exploitation and its Post-War Consequences. Pp. 75. (London: Royal Institute of International Affairs.) 1*s.* 6*d.* [82

City and County of Bristol: British Museum and Art Gallery. Report of the Committee for the Five Years ended 31 December 1943. Pp. 24+4 plates. (Bristol: Bristol Museum and Art Gallery.) [82

Royal Meteorological Society. Bibliography of Meteorological Literature. Prepared by the Royal Meteorological Society with the collaboration of the Meteorological Office. Vol. 5, No. 5 (January—June 1943). Pp. ii+71–96. (London: Royal Meteorological Society.) 2*s.* 6*d.* [92

Forestry Commission. Post-War Forest Policy—Private Woodlands. Supplementary Report by H.M. Forestry Commissioners. (Cmd. 6500.) Pp. 12. (London: H.M. Stationery Office.) 2*d.* net. [92

British Standard Glossary of Terms used in Telecommunication. (B.S. 204, 1943.) Pp. 108. (London: British Standards Institution.) 3*s.* 6*d.* [102

Proceedings of the Royal Irish Academy. Vol. 49, Section A, No. 8: The Earth's and the Sun's Permanent Magnetic Fields in the Unitary Field Theory. By Erwin Schrödinger. Pp. 135–148. 1*s.* Vol. 49, Section A, No. 9: Non-Linear Quantum Electrodynamics of the Vacuum. By the Rev. James McConnell. Pp. 149–176. 1*s.* Vol. 49, Section A, No. 10: Relations between Statistics—The General and the Sampling Problem when the Samples are Large. By R. C. Geary. Pp. 177–196. 1*s.* Vol. 49, Section A, No. 11: On the Production of Mesons by Light Quanta and related Processes. By J. Hamilton and H. W. Peng. Pp. 197–224. 1*s.* 6*d.* Vol. 49, Section B, Nos. 12, 13: Description of *Aspilota dentifemur* sp. nov. (Hymenoptera: Alysiidae), by A. W. Stelfox; On the Identification of Two Species, *Alysia nervosa* and *Alysia fuscicornis* of Haliday (Hymenoptera: Alysiidae), by A. W. Stelfox. Pp. 201–212. 1*s.* (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd.) [102

Proceedings of the Aristotelian Society. New Series, Vol. 43: Containing the Papers read before the Society during the Sixty-fourth Session, 1942–1943. Pp. xxvi+222. (London: Harrison and Sons, Ltd.) 25*s.* net. [112

Imperial Bureau of Horticulture and Plantation Crops. Technical Communication No. 14: Progagation by Cuttings and Layers; Recent Work and its Application, with Special Reference to Pome and Stone Fruits. By R. J. Garner. Pp. 80. (East Malling: Imperial Bureau of Horticulture and Plantation Crops.) 3*s.* 6*d.* [142

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