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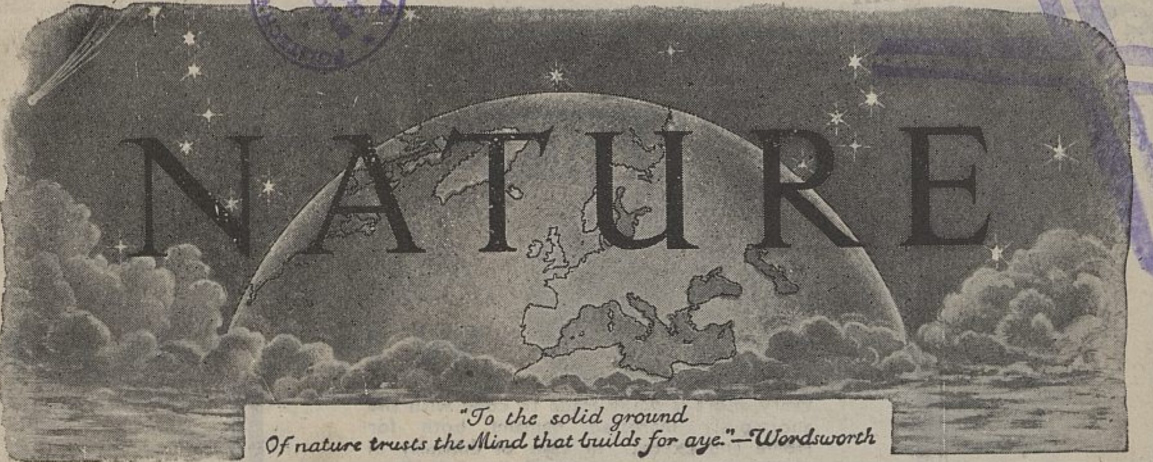

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NATURE

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COLONIAL RESEARCH AND DEVELOPMENT

THE Colonial Research Committee appointed in June 1942 to advise on the expenditure of the £500,000 a year provided by the Colonial Development and Welfare Act, 1940, for the promotion of research and inquiry in matters affecting the Colonies and to advise upon and co-ordinate the whole range of research in the Colonies, has now presented a progress report on its first year's work, 1942–43*. The report includes an account of developments leading to the establishment of the Committee, the functions of which were outlined by Mr. Harold Macmillan in a statement to the House of Commons on April 28, 1942 ; the first interim report of the Colonial Products Research Council, constituted under the chairmanship of Lord Hankey in January 1943, is appended (see p. 133 of this issue), together with lists of Colonial agricultural institutes, medical research institutes, schools of medicine and veterinary research stations, centres for the collection, distribution and interchange of scientific information on agriculture and medicine, supported jointly by all countries of the British Commonwealth, and particulars of research schemes under the Colonial Development and Welfare Act, 1940, prior to the establishment of the Committee. The report of the Colonial Research Committee is signed by Lord Hailey as chairman, and it is proposed to present an annual report in April in future, that is, at the end of the financial year.

This first report shows an outlook which in itself indicates how wise was the decision to establish the Committee, and also the immensely important contribution to Colonial development and welfare which the Committee will be able to make if adequately supported. The preparatory work described in the Report shows that the Committee has started on the right lines. It has already indicated certain general features of Colonial research that require early attention, and the wide view of its functions taken by the Committee should be all the more fruitful when, after the War, the prosecution of extended schemes of research becomes possible.

The Committee accordingly has not limited itself to the examination of proposals laid before it by Colonial Governments or by other bodies. It has conceived it as its duty to study the whole field of scientific inquiry ; to distinguish the parts of it requiring attention, and to ensure that gaps in it are filled wherever possible. In accordance with this conception of a planning commission for the whole field of Colonial research, the Committee has first limited itself to a preliminary survey of the special problems and needs of Colonial research as a whole, and to an examination of the general principles which should be followed in its organization. Comprehensive planning of future developments now will enable the Government the better to put schemes of research into operation as soon as scientific men and others now engaged in war duties are free to participate in Colonial development.

* Colonial Research Committee. Progress Report 1942–1943. (Cmd. 6486.) Pp. 12. (London : H.M. Stationery Office, 1943.) 6*d*. net.

Naturally enough, the Committee has not yet been able to complete its survey of the major subjects which must come under its review. Its first task has been to form an estimate of the character of the research work already undertaken in the Colonial territories. On this point the Committee, while impressed with the efforts that have been made by research workers in these territories, often in the face of great difficulties, and with the value of many of the results achieved, is convinced that scientific facilities and terms of service must be improved, and new or additional methods of recruitment and organization devised if research is to play an effective part in the development of the Colonies. The isolation of the research worker in the Colonies from fellow-workers in his own, or in kindred, fields of science is one fundamental difficulty. Again, in some Colonies, the shortage of technical staff has obliged research workers to give much of their time to routine work, and even if they are freed from the pressure of routine work, there is a tendency for research problems to be defined too exclusively by local and temporary interests, without due regard to scientific possibilities, or to the scale on which a given investigation must be planned if it is to have any reasonable hope of success.

Under such conditions there will always be difficulty in attracting the ablest research workers to the Colonies, and the Report rightly stresses the necessity of obtaining men and women of outstanding ability in order to make Colonial research effective. To meet these difficulties, the Committee recommends, first, that further attention be given to the special conditions of service of research officers. Of these, the most important is greater freedom of exchange between universities and institutes in Great Britain, in the Colonies, and in other countries where similar research problems are being studied. Study-leave would mitigate the isolation of the Colonial research officer, but by itself is not enough. The Committee suggests that it is worth considering the possibility of establishing separate research services under some central organization in the United Kingdom, possibly the Colonial Office, which would provide a pool of scientific workers on which Colonies could draw.

Both this proposal and the allied suggestion of the formation of a sort of 'scientific volunteer reserve' of workers normally employed in independent institutions reflect the spirit which has animated the recent proposals for the reform of the Foreign Service, but their implementation will involve attention to such conditions of service as salary scales, pensions and the like, and the elimination of anomalies. Equally, they cannot be considered in isolation from the discussion of the status and remuneration of the research worker generally, which has been initiated by recent reports on industry and research. Colonial research, whether from the point of view of staff or organization, must, in the final issue, be planned as part of an imperial policy of research.

A second means suggested by the Committee of mitigating the isolation of the research worker in the Colonies is the development of centres of research and learning in the Colonies themselves. The Committee has been in touch with the Higher Education Sub-Committee of the Advisory Committee on Education in the Colonies, which has been studying the possibilities of developing facilities for research in such bodies as the Universities of Malta, Jerusalem, Ceylon and Hong Kong, and institutions which may prove to be the nuclei of future universities, such as Raffles College at Singapore, Makere College in East Africa, and Achimota and Yaba Colleges in West Africa. An increase in research facilities at these centres would raise the standard of learning in these nascent universities, and do much to remove the sense of isolation at present inseparable from Colonial research.

In regard to the organization of research, the Report emphasizes the need for an extended range of research. The investigations so far undertaken have been directed mainly to subjects involving problems of immediate importance. Commercial undertakings have played a large part in the development of research which has been of direct interest to them. Inquiries of great importance have probably been postponed because they do not fall within the purview of the main Colonial departments, and basic surveys, either topographical or geological, do not exist in many Colonies. Few systematic studies of the flora and fauna of Colonial areas have yet been undertaken, and more detailed investigations of the species of fish living in local waters and their life-histories are indispensable for the further development of fisheries in the Colonies. Ethnological and linguistic surveys are lacking in some areas, as well as data on social and economic conditions, and much remains to be done in the field of vital and census statistics.

For such reasons the Committee considers that an important use of the funds now available will be the extension of the scope of investigations to be undertaken in the Colonies, especially in the poorer territories. By making it possible to organize long-term and short-term basic surveys and to promote research on general environmental problems as well as in the whole field of social research, the new financial provision should do something to meet a further difficulty encountered in the past in the lack of continuity of research. Full value cannot be obtained from research unless continuity is ensured, and one of the main advantages of the new provision of funds under the Colonial Development and Welfare Act is to secure such continuity.

Next, the Report points to the need for central and regional organization, not only to achieve the most economical use of the slender resources of research workers and equipment available, but also as the easiest way of securing that co-ordination between the different fields of research which is necessary if comprehensive investigations are to be made of specific problems, especially those related to development programmes. Machinery for securing the co-ordination of different types of research is particularly important at the present stage of development of the Colonies, and it is well to remember that the frontiers of scientific research do not coincide with political boundaries. Co-ordination of work to be carried out jointly in several Colonies or in Colonial territories and those of neighbouring Dominions or of other States may be necessary; but in discussing the question of Government control of Colonial research, the Committee emphasizes the necessity of seeking the greatest elasticity in the organization of research. Generally, it should be so organized that Government investigations and those conducted by academic or other bodies go on freely side by side.

In addition to these general conclusions, the Committee has reached a number of conclusions in regard to particular fields of research so far surveyed. The Committee accepts the proposal of the Colonial Survey and Geophysics Committee that topographical and geodetic surveys should be planned by a central Colonial survey organization, and recommends the preparation of a detailed scheme for such an organization, so that the necessary plans can be put into operation at the end of the War when men should be available. Similarly, it recommends the preparation without undue delay of detailed proposals for an extension of Colonial magnetic and meteorological services, in view of their importance to mining developments, to agriculture, and to wireless transmission and radio navigation. A scheme of this kind is also being considered by the Colonial Survey and Geophysics Committee.

The Committee's review of the facilities for forestry research has led to the conclusion that the central organization of Colonial forestry research is already adequately provided by existing organizations, but regional centres will be necessary in the Colonies for research into forest products, and in most Colonies the staff concerned with entomological research and sylviculture should be considerably increased. The importance of research into the systematic classification of Colonial fishes and the study of their life-histories has already been indicated, and, stressing the economic importance of Colonial fisheries and its bearing on nutrition, the Report also points to the need for investigations into methods of fishing, of preserving and processing fish, as well as on the marketing and transport of supplies. For this purpose further marine fisheries research stations are required, especially in the West Indies, West Africa and East Africa. In addition to extension of the existing fisheries departments of Ceylon, Malaya and Hong Kong, establishment of a regional research station for freshwater fisheries in East Africa is suggested.

The Committee received a survey of the present position of agricultural research in the Colonies approved by the Advisory Council of Agriculture, Animal Health and Forestry, and reviewed the progress in the organization of agricultural research since the recommendations of the Imperial Agricultural Research Conference in 1927 and the two Lovatt Committees on Agricultural Research and Administration in the Colonies in 1927 and 1928. It is considered essential that research work on a full scale should be resumed at Colonial centres as soon as possible, with such measures of reorganization and extension as may be necessary to cope with post-war development. In addition to further provision of staff and facilities for research on the cytological side of plant genetics, on plant physiology with special reference to plant disease, on virus diseases of plants, and on trace elements, on the control of insect pests by biological means and by the use of insecticides, and on insect pests of stored products, etc., the importance of planning agricultural research in line with modern views of agricultural policy as reflected in the pronouncements at the United Nations Conference on Food and Agriculture at Hot Springs is stressed. A policy of raising the standard of living of Colonial peoples and particularly their standards of nutrition involves co-ordinated schemes of land utilization surveys, forestry research, experiments in methods of improved cultivation in backward areas by the introduction of better strains of crops and mixed farming systems suitable to local conditions, improved storage, grading and marketing and a co-ordinated policy for improving human and animal nutrition; for such planned development the closest interdepartmental co-ordination will clearly be necessary.

While medical research has not been considered by the Committee in any detail, its survey of the position of veterinary research has led to agreement that regional research centres in animal health are required for each group of territories, with, if necessary, separate laboratories for the production of biological preparations. Each Colony should also have a small laboratory for the study of its own local problems and its own pathological work. Again, while in the initial stages veterinary research in the Colonies should be directed towards the control or elimination of the most destructive diseases of stock, this must be followed by research directed towards the improvement of livestock with a view to the maintenance of healthy and productive herds to supply the nutritional and economic needs of the Colonial peoples. For this purpose, research on animal health requires organization on a wider basis, and the inquiries involved will call for the co-operation of teams of workers in different scientific fields.

Finally, in regard to the neglected field of the social sciences, in the absence of appropriate organizations, the Committee has sought the advice of groups of experts in linguistics; demography, anthropology, and social surveys; economics; systems of colonial law; colonial administration; and education and psychology. The organization of research in the social sciences will be considered further on the basis of the reports of these groups. The Committee is also taking every opportunity of establishing contact with interested individuals and organizations in other countries, and particularly with those within the British Commonwealth. It has also recommended the establishment of Colonial research fellowships, so as to build up a cadre of young men and women familiar with colonial scientific problems and able to help in their solution; and it may be of value to finance occasional pieces of research by senior scientific workers holding academic or other research posts.

There can be no question as to the importance of the work to which the Colonial Research Committee has addressed itself, both from the point of view of implementing the new colonial policy and realizing the hopes aroused by the Hot Springs Conference. It has a close bearing on the whole question of world trade and full employment policy, and the Committee rightly makes it plain how closely the first steps are dependent on man-power. This Report deserves not only the close attention of scientific workers but also careful study by all those bodies concerned with demobilization, such as the interdepartmental committee under Lord Hankey to ensure the relation of training and educational facilities to prospects of employment at home and abroad and to university development and reorganization. The basic problems of colonial research and their implications are fairly stated, and scientific workers must not shirk the responsibility of seeing that the appropriate action is taken or of facilitating the difficult task of securing the large amount of co-operation which in such fields as agriculture and animal health is as indispensable a condition of scientific as it is of social and economic advance.

THE HOUSE OF MACMILLAN

The House of Macmillan (1843–1943)
By Charles Morgan. Pp. xii+248. (London: Macmillan and Co., Ltd., 1943.) 8*s*. 6*d*. net.

IT was on November 10, 1843, that two young Scottish booksellers, Daniel and Alexander Macmillan, published their first book, "The Philosophy of Training", by A. R. Craig, late classical master in Glasgow Normal Seminary. They were setting up a bookselling business in Cambridge (now that of Messrs. Bowes and Bowes), but they had other ambitions, "to realize some of their ideals" by publishing good books—and their London office at 57 Aldersgate Street was the first step towards their establishment as one of the greatest of publishing firms. Both had youthful experience with booksellers and publishers, and in the main had educated themselves; but they made the acquaintance of Archdeacon Hare, and through him of F. D. Maurice; in Cambridge, customers, young and old, became friends, with lasting respect and affection, and their rooms became a centre of serious discussion, social and theological. Alexander did much for the Working Men's College in Cambridge; Daniel defended Maurice in private and in public. Meanwhile, authors multiplied and books appeared, some of them still in service, such as the translation of Plato's "Republic" by Davies and Vaughan. Of the early authors, best known are Charles Kingsley, and Tom Hughes, whose "Tom Brown" had immediate success. Daniel had never been strong, but his wise counsel was a mainstay until his early death in 1857; and one of his projects, the London branch at 23 Henrietta Street, Covent Garden, was realized soon after, with a similar club-like appendage, where 'Tobacco Parliaments' attracted an increasing number of guests—poets, historians, men of science, and story-tellers, among them Tennyson, Huxley, Dicey, Palgrave, and Herbert Spencer.

These were the notable beginnings of an enterprise which has more than justified them. The story of it is a remarkable cross-section of the literary and intellectual world of the Victorian age, so strenuous and serious in pursuit of many divergent aims, but behind its colossal gravity so intensely human. There is a distinction in degree, rather than in kind, between biography and history; and when biography deals with a family, and with two or three generations, as here and in the recent "Time and Chance" of Dr. Joan Evans, the distinction begins to fade. When it also deals with a corporation, and with the profession which it subserves, it almost disappears, unless the personalities are unusually forcible and congenial. On the other hand, the more significant the narrative, as an illustration of contemporary notions and trends, affecting those persons as well as affected by them, the closer does the work come to strictly historical writing. Few recent books have given so vivid and wide a glimpse into the cultivated life of London during the last hundred years, or brought so many portraits into one 'conversation piece' describing the setting of their common interests and pursuits; or analysed so critically the institution which interconnected them, as well as the persons who created and maintained this common bond; the combination of business ability, critical judgment, and personal humanity which gives a publisher's life its opportunities and its rewards, in fame and in friendship.

Being eminently business-like men, the Macmillans have kept ample record of their doings, their experiences, and their thoughts; and Mr. Morgan has evidently had liberal access to these archives; even in Daniel's frequent absences through ill-health, Alexander's copious correspondence with him preserved unusually intimate detail for the earlier years. As their business grew, they all became more dependent on critical reports from trusted and experienced advisers, among whom John Morley was the most eminent, and is the most often quoted. Later, the long memories of loyal retainers add picturesque detail and wholesome atmosphere to the written records: good masters are well served. But it is clear that many important decisions were taken on personal impressions of one or more of the partners, as well as on their reading of manuscripts. Especially was this so in early days, when authors like Maurice, Kingsley and Hughes were their personal friends, and others, afterwards famous, were the contemporaries or the juniors of the head of the firm, himself still in the forties. That is the significance of the letters quoted here, to men like Hardy, or Rossetti, or Watt; of the design on the cover of so many Macmillan books—"the stars for heavenly light and glory, the acorns for earthly growth and strength, the tree for useful industry, the butterfly for beauty pure and aimless"; of the invention—for it was no less—of the "Golden Treasury", the "Globe Shakespeare" and its companions, and the "English Men of Letters" series. As Mr. Morgan writes of publishing generally, "its character certainly, and perhaps even its romance, may be more truly said to arise from its sharp intermingling of calculation and industry with intuition and mere chance". In no calling does so much depend, as in publishing, on the character and judgment of the publisher.

On more than one occasion, by its grasp of principle and obstinate adherence to policy, the house of Macmillan rendered public service to everyone concerned in the production and distribution of books. Of these the most important in retrospect were the discussions of literary copyright, from Alexander Macmillan's letter to Sir John Coleridge on July 30, 1873, to the new Copyright Act of 1911, in the framing of which Frederick Macmillan had a share; the Net Book Agreement between the publishers and the booksellers achieved after long negotiations in 1899; and the consequent 'Book War' with *The Times* Book Club in 1906–8, in both of which he was again in a leading part. Now that this ferocious struggle is long over, it is possible to put the whole matter in an impartial and historical way, and Mr. Morgan has done this well.

Another great service was the publication of English classics, and also modern books such as Morley's "Life of Gladstone" in popular but well-printed editions for a few pence a volume or part. It takes its place in the same historical perspective as the University Extension Movement, and the copious supply of elementary text-books by first-rate authorities, especially in classics and in natural science, for a new and very wide public in the secondary schools. Mr. Morgan gives examples of the great care taken personally by members of the firm, and especially by Maurice Macmillan, in the selection and—one may almost say—the training of authors, in this important branch of literature.

Very fortunately, as its business widened, the House of Macmillan was able to supply within the family circle a succession of able men, each moreover with a contribution of his own. In the general conduct of affairs, Frederick Macmillan's versatile and thorough acquaintance with the technique of printing and bookselling, and his long residence and family ties in North America, made him the natural successor to his uncle Alexander. Maurice, hard-headed but as fertile in ideas as any of his brothers, "carried the unspectacular but important responsibility of the firm's educational department" already mentioned, and out of this developed the large business with India, which had engaged Alexander's attention long before, on its educational side, and profited by the wise experience of Sir Roper Lethbridge of the Bengal Educational Service. The policy was the same as at home, "to get the very best men in each kind of knowledge to write the most elementary books", but they had to be written to meet Indian needs and conditions, and Maurice's long journey in 1884 was a real contribution to the advancement of education in India.

George Macmillan, a King's Scholar at Eton, who had learned to love Greece with Mahaffy, brought wide unacademic insight into many aspects of classical scholarship, dealt with such portentous growths as Frazer's "Golden Bough" and Arthur Evans' "Palace of Minos at Knossos", founded and long directed the Hellenic Society and (with Walter Leaf) was the earthly providence of the British School of Archæology at Athens, honorary secretary of the Royal College of Music, an active member of the Society of Dilettanti for which the famous "Antiquities of Ionia" were completed at last: and he could take a hand both in Groves' "Dictionary of Music and Musicians" and in the "Cambridge Natural History", examples of the "long-term publishing" characteristic of the House throughout. If his "austerity on duty" was "a little intimidating" to the young, the intense devotion of this precise ascetic-looking Olympian to 'unpractical' but remunerative enterprises was a peculiar stimulus until the man himself was revealed.

Less easy to assign is the responsibility and the credit for the firm's record in the advancement of natural knowledge by many great text-books, and above all by the publication of NATURE. "The risk was not small" and it was nearly thirty years before it "began at last to pay its way" as an "intelligence service" among men of science themselves, as well as for the public. It was its peculiar good fortune to have had only two editors between 1868 and 1938, namely, Sir Norman Lockyer (1868–1918) and Sir Richard Gregory (1918–38) (see also NATURE of February 27, 1943, p. 231), whose eightieth birthday is celebrated on January 29 (p. 133).

It is only possible to select from Mr. Morgan's intimate and congenial retrospect the more conspicuous achievements, and some indications of the principles and policy on which they were based. But it is the humanity, the personal enthusiasms and convictions, which make the record so significant. From the first, the Macmillans "did their best to realize some of their ideals" by publishing good books by the right people. Long may they continue to do so.

JOHN L. MYRES.

PSYCHOLOGY OF INTERNATIONAL PEACE

Conscience and Society

A Study of the Psychological Prerequisites of Law and Order. By Dr. Ranyard West. Pp. iv+260. (London: Methuen and Co., Ltd., 1942.) 15s. net.

IT is very important that psychologists should play their part in the affairs of post-war years, and especially in the coming attempt to establish international peace on a sure footing. They must show that they have a genuine contribution to make, and that they are capable of making it in a way which can be understood and utilized by people without the psychologist's special training. It must be a clear and simple contribution, to the point and free from disabling controversy. It must show the wisdom and restraint which come from a deep insight into life and experience.

On account of these needs we are grateful to Dr. Ranyard West for his book "Conscience and Society". He has presented, in serious and scholarly manner, arguments which show at least some of the essential factors in the great problem of establishing international peace. There are, in his opinion, two major groups of impulses in mankind which are related to this problem. They are the social and the self-assertive or aggressive instincts. The social or co-operative instinct he believes to be normally uppermost, and it seems to him the main impulse behind our daily comradeship. The aggressive instinct is biologically understandable as providing each individual with the impulses of self-defence and self-assertion; but in his view of human nature, it is more like a reflex occasionally aroused than like an appetite in need of periodical gratification. A third force operates in man's social life, namely, conscience, and this, according to Dr. West, is the fear of the loss of the love of our fellow-men through the self-interested expression of our own assertive and aggressive impulses. This conscience supports the social against the aggressive urge, and helps to preserve peaceful and constructive social relations.

Every individual, however, is liable to outbursts of personal aggression, and those who are neurotic owing to the persisting after-effects of infantile and childish disturbances of emotion are peculiarly liable to such outbursts. Hence external control, government and law are needed to strengthen conscience and enforce its demands in moments of weakness. In this respect groups and nations are comparable with individuals. Their goodwill depends on circumstance, and their loyalty to ideals of international peace depends on the vagaries of the self-interest of national and sovereign powers.

Thus, in the establishment of world peace, nationalism and the self-interest of sovereign States, which are always potentially aggressive in self-defence, must be given second place to an international organization the function of which will be to control and arbitrate. It must be able to do this without national self-interest, but impartially in the cause of peace, just as, in individual relationships to-day, justice can be carried out with a wisdom which is independent of personal bias and prejudice. Social philosophers, such as Hobbes, Locke, Rousseau and Freud, seem to have viewed man's problems as if reflected by their own personal fears and peculiarities of character. Dr. West points this out and tries to take a truly objective view.

Easy though it might be to criticize Dr. West's book, it would not be easy to destroy its essential meaning. The scheme of two instincts, a 'good' and a 'bad', of which the 'good' is the usual winner, supported by a generally beneficent 'conscience', are excellent as the basis for the exposition of his theme, the importance of which cannot be denied; but this scheme is not sufficient to account for the complexities of life as we know them, and could never form the foundation of social psychology for a deep thinker. The book is overloaded with criticism of other writers, especially Freud, on whom, nevertheless, Dr. West leans very heavily. The shortcomings of Freud's genius are too clear to need such meticulous underlining. The author lays too much stress on the study of obsessional neuroses, and he appears to overlook the part played by psychotic tendencies in group and individual battles and misunderstandings. It seems strange that so experienced a psychologist should think that internal mastery and external control are the only ways of dealing with selfish aggression in group or individual. He does not realize the vast extent to which constructive social life itself depends on the proper use of individual aggression.

These objections, and others which might be made, however, are only asides in a review of so estimable and sincere a work, and can be forgotten in our gratitude to Dr. Ranyard West for giving us a book which is a valuable pointer in one of the directions in which psychology can contribute to the future welfare of mankind. A great merit of the book is that its author has attempted to bring together social philosophers, legal authorities and psychologists in his effort to help in the solution of what must be for them a common problem.

R. W. PICKFORD.

THEORY OF THE TRANSMISSION OF VERY SHORT RADIO WAVES

Microwave Transmission

By Prof. J. C. Slater. (International Series in Physics.) Pp. x+309. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1942.) 24*s*. 6*d*.

DURING the past ten years or so the published radio technical literature has contained the descriptive results of many investigations into the nature, properties and possible applications of the very short electric waves resulting from the generation of oscillations at frequencies greater than 100 megacycles per second. While the best mode of designating these frequencies and the corresponding wave-lengths is a very controversial matter, one general term is frequently applied, namely, 'microwave'. Any possible misunderstanding as to the scope of the book under review is removed at the start by the author who, in the first sentence of the preface, states that "Microwaves are electromagnetic waves of wave-lengths that we may take, for definiteness, to be between 1 centimeter and 1 meter". It is then pointed out that these waves are unique in the whole range of electromagnetic waves, in so far as the wave-length is of the same order of magnitude as the dimensions of ordinary laboratory apparatus, a feature which makes possible the use of experimental methods differing markedly from those used formerly in radio-frequency technique.

Prof. Slater's book deals with the general principles and fundamental theory underlying the transmission of these short radio waves from point to point, without being concerned with the problems of generation and reception. Microwave problems differ from ordinary circuit problems, in that it is no longer valid to deal with lumped impedances, but thought must be centred on the distribution of the inductances and capacitances around or along the circuit. In addition, conductors in the microwave region are very different from the open-wire circuits used at longer wave-lengths, since such circuits would lose too much energy by radiation to form useful transmission lines. These lines take the form of co-axial cables, consisting of a rod carried concentrically within a hollow pipe, or even of the hollow pipe alone.

From these considerations the book opens with a chapter on the theory of transmission lines, viewed as an electrical network; and then proceeds in Chapter 2 to a discussion of Maxwell's equations, and the production and properties of plane electromagnetic waves. This leads naturally to consideration of the propagation of electromagnetic energy along rectangular wave-guides, and to the general problem of transmission lines when these are hollow conductors. So far the work is confined to the study of disturbances propagated along one definite direction, but when the transmission line or wave-guide terminates in an antenna in free space, the resulting radiation will be emitted in all directions. Chapters 5 and 6 therefore deal with Maxwell's equations in spherical co-ordinates and with the principles of the various directive devices used with antenna systems for very short wave-lengths. The final chapter in the book deals with the coupling of coaxial lines and wave guides, considering particularly the problem of radiation and absorption from a dipole inside a rectangular wave-guide.

Altogether the author would appear to have attained his objective of producing "a book of an intermediate range of difficulty". While an extensive mathematical knowledge is not assumed, some acquaintance with classical electromagnetic theory and Maxwell's equations is necessary, and the work should present little difficulty to the first-year graduate student in physics or electrical engineering, or to the senior worker with a good training in electricity. In view of the extensive application at the present time of the range of wave-lengths covered by the book, this should be found of great interest to many workers and students, even though it does not deal with practical or experimental technique.

UNIFICATION OF BOTANICAL SCIENCE

By Prof. C. W. WARDLAW
University of Manchester

"Botany is the science which treats of plants."—*Oxford English Dictionary.*

"Every speculation about a single phenomenon wrenched from the continuity of life, is playing indeed a thankless part in the present condition of the natural sciences."—SCHLEIDEN, 1838.

"An unflinching determination to take the whole evidence into account is the only method of preservation against the fluctuating extremes of fashionable opinion."—A. N. WHITEHEAD, 1926.

"An upward outlook is in itself a practical application of any evolutionary view."—F. O. BOWER, 1935.

ANY biological phenomenon can be considered from several different points of view, each of which may lead to the formulation of particular and distinctive concepts. In some instances concepts relating to different aspects may overlap: in other instances they may belong fundamentally to different categories. Now, it is a fact that botanical science has developed erratically and spasmodically; botanists have embraced strange and irreconcilable philosophies; they have welcomed innovations and canalized them into fashions or moulded them into new branches of the science. Moreover, the results forthcoming from the several distinctive phases have not invariably been studied with due regard to their mutual relationships, nor have they necessarily been envisaged as contributing directly to a generalized scheme. The piecemeal character of the scientific advance and the diversity of its branches of underlying philosophy have increased notably during the last fifty years; for it has been a period of great, if non-co-ordinated, activity along many seemingly divergent lines of inquiry. Cogent reasons, therefore, exist for the view that the time is at hand when an effort should be made to achieve some closer integration of the science as a whole.

As a result of the growing volume of research on almost every branch of botany and the concurrence of certain contemporary lines of investigation, there is a reasonable hope that certain gaps that have hitherto hindered synthesis may in due course be bridged and that this may lead towards a real unification of outlook. To some, no doubt, this may appear as unjustifiable optimism. The question may indeed be asked why this topic is considered to merit special attention at the present time. It may be argued that botanical science does not in fact lack unity, that it has been adequately unified at various times in the past, or that complete unification is difficult or even impossible. Moreover the nature of the unification envisaged itself requires elucidation: What kind of unification and for what purpose? I have in mind both the conceptual and methodological aspects: the former is concerned with general questions, that is, possessing significance for the plant kingdom as a whole; the latter considers the results of a particular discipline in relation to those of all other relevant disciplines, instead of such results being treated in comparative isolation. It is this latter aspect of unification that I consider of particular importance at the present time.

It seems evident that failure to achieve some progressive method of integration in the near future will be attended by such an accumulation of non-co-ordinated data as to dismay contemporary botanists and bewilder their successors. There is no novelty in this view, but emphatic reiteration seems timely. In the long view, teaching and research are inseparable; failure to collate the main results of contemporary and past work will certainly militate not only against reasonable advance but also impede the proper teaching of the subject.

In the realm of biological science, where a sense of ever-increasing complexity appears to be the chief reward of the most profound investigations, the less complicated structure and mechanism of plant life, as compared with animal life, might be expected to afford a more direct approach to the fundamental problems of organic Nature. Hence an unbiased observer might take it for granted that botanists would automatically take the lead in the formulation of new concepts and the enunciation of broad generalizations. Reference to some recent works on general biology can scarcely be considered to support this view; indeed, a certain neglect of botanical work is apparent by adherents of other branches of biology. It may be that botanists are to blame; for while collectively their science abounds with new and impressive discoveries, it may be argued that these have not been presented in such a way as to be readily accessible to the general reader. The justification for seeking to co-ordinate the various branches should lie not only in its desirability on philosophic grounds but also in its results. Past prophecy as to the future direction of scientific achievement has not enjoyed such a success as to encourage present attempts, but it seems evident that a period of great synthetic development is on its way. This potential development, however, will only become actual if a synthesis, dynamic and progressive, of all new knowledge is steadily maintained in some reasonably accessible form. Thus a contributory channel of specialized research would be seen not only in relation to neighbouring channels but also to the course of the main stream.

Botany and the Botanists

"Botany is the science which treats of plants" (*Oxford English Dictionary*), and in an extended definition is usually understood to include a consideration of their growth, development and reproduction, the functions of their organs, their origin, systematic affinities, geographical distribution and relation to their environment. Some years ago Prof. W. Stiles indicated that in his view there could be no such thing as a *general botanist*: that an investigator may take a sympathetic interest in other branches of the science and realize the bearing of such work on his own, but that the latter, in these days of specialization, must necessarily lie in one particular field. Clearly in such a statement there is ground both for agreement and dissent. In so far as an investigator fails to realize the relation of his work to the science *as a whole*, so may he fail to appreciate the actual and potential development of the subject in his time.

What, then, do we hope to make of "the science which treats of plants"? What, in particular, is to be the relationship of the specialized branches, for example, plant biochemistry or genetics, to the parent science?

The last five decades have witnessed a great expansion of botanical research in the course of which new aspects, each requiring detailed investigation by means of special technique, have become distinct, specialized and almost separate branches of biological science. To-day, a botanist tends to be labelled systematist, cytologist, geneticist, ecologist, mycologist, morphologist, palæontologist, physiologist or biochemist, the underlying assumption being that he is that and little else. A further unfortunate consequence of specialization lies in the fact that common ground for discussion becomes more and more difficult to find, and in extreme cases may even lead to the view that it does not, for practical purposes, exist. Although an official cleavage between botanical morphology and physiology was avoided at the British Association meeting of 1894 in Oxford, nevertheless an adequate sense of mutual aid in the common pursuit is still lacking. The morphologist will tell you, with some over-emphasis but not without justification, that when he looks into text-books of physiology in search of information bearing on his own work, he finds that such books can tell him little that he specially wants to know; and the modern physiologist, though not habitually addicted to helping himself by making the fullest use of morphological observations, rather tends to view the professed morphologist as a relic of a former phase of botanical development and as a less adaptable and less inventive scientific man who is still plodding along in an overworked field; moreover, he, too, may complain that morphological literature fails to provide the information he specially requires. So, too, uneasy relationships exist between other and newer branches of the science. Each new aspect that arouses enthusiasm is soon attended by a profuse outpouring of specialized literature, and this, no doubt, must be accepted as being in the nature of things. But several important consequences should not be overlooked. These include: (1) vast accumulations of reading matter which are such that a worker *in any single branch* has to read constantly to keep up to date; and (2) an increased specialization of outlook, which, if left uncorrected, will make for a progressive disintegration of the science as a whole.

Now, no one would desire that specialization in the various branches of botany should cease. Such close investigation of particular phenomena is of the very nature of the scientific method. Indeed, the more facts these branches can produce, the better for biological science as a whole, provided they are made readily available to readers working in other branches. The crux of the problem, then, is this: How is the contemporary *botanist*, conscious of the need *for achieving a full and coherent account of the plant and its life*, to make the best use of the several contributory branches without wishing to deny to them the fullest freedom to pursue their own aims? For two things are certain: (1) no single human being can now hope to read in detail the literature of the several special branches; (2) no particular branch will relinquish its aims or limit its scope for the sake of the mother-subject. Thus it is not a question of re-uniting the several separate branches, or of making any one the hand-maiden of another, but of being able to synthesize or integrate the facts of these branches in the interests of the central aims of botany.

Before attempting to take the matter further, it may be advantageous to consider briefly some selected aspects of the development of botanical science.

Early Developments

It is almost certain that the early systematists, having arranged in orderly fashion the species of plants known to them, must have been conscious of having imparted coherence where none had previously existed. Here it is appropriate to refer to the works of John Ray (1628–1705), of whom Sachs has written that he "not only knew how to adopt all that was good and true in the works of his predecessors, and to criticize and complete them from his own observations, but could also joyfully acknowledge the services of others and combine their results and his own into a harmonious whole". The tribute is deserved, for though Ray's "Historia Plantarum" consists essentially of a series of descriptions of all plants then known, the work is prefaced by an account of morphology, anatomy and physiology as then understood. Later, too, Linnæus, having achieved the completion of his system, must have been conscious of having created a new and desirable unity. Along entirely different lines the German botanist, Caspar Wolff, discussed general questions such as the fundamental nature of the shoot system, and concluded, as stated in his "Teoria Generationis", 1759, that he saw nothing in the plant but leaves and stem. Later, inspired no doubt by Wolff's generalization, Goethe formulated his theory of metamorphosis in which all the various and diverse appendages of the shoot in higher plants were regarded as being the metamorphosed products of a single fundamental organ, the 'ideal' leaf. Here, indeed, the nature philosopher had conferred a unity on the objects of his study, but as Schiller pointed out to him, the abstract conceptions which he employed belonged to the realm of ideas rather than of facts.

The scholastic tradition which prevailed during the first half of the nineteenth century died hard, and botanical science made indifferent headway until Schleiden trenchantly preached a new gospel—that the highroad to new discovery lay in the study of development. It remained for his disciple Wilhelm Hofmeister to show what could thus be done. To view his work in proper perspective it is necessary to realize how very little was then known of the Cryptogams and indeed of the life-history of higher plants. The reproduction and embryology of Bryophytes and Pteridophytes constituted practically an unexplored field, while precise data relating to the development of the embryo-sac, fertilization and embryology in the higher plants were still being collected—all this rather less than a hundred years ago. The contemporary botanical world may well have been astonished when it first read the curious catalogue title of Hofmeister's paper: "Comparative Researches on the Germination, Development and Fruit Formation of the Higher Cryptogams (Mosses, Ferns, Equisetaceæ, Rhizocarpaceæ and Lycopodiaceæ) and the Seed-formation of the Conifers" (1851). It must have appeared as if the wrong things, mosses and gymnosperms, had somehow been run together for comparative treatment. But this was no fallible production, nor was the strange association of data an indication of faulty judgment, for the young German botanist was telling the world that mosses, liverworts, lycopods, equiseta, ferns, gymnosperms and phanerogams all shared a common life-cycle, characterized by the same critical events and developmental phases, and by a recurrent alternation of generations. Here, on a substantial basis of observation, was a synthesis which conveyed a sense of unity hitherto unknown. Later, in 1896, following on the discovery of chromosome behaviour, Strasburger was in a position to announce the further important generalization of the relation between the chromosome-cycle and the somatic-cycle.

Hofmeister's General Morphology

These and other examples which could be quoted afford evidence of the way in which new data and the generalizations which could be based on them not only widened the scope of botanical science but also conferred on it a new sense of coherence. These instances, however, do not convey any adequate idea of the *methodological unification* which I consider to be desirable. For such a discussion the starting-point lies in the works of Hofmeister, for he was not merely concerned with preparing descriptive accounts of changes in form during development, but he also asked himself such questions as: How does the observed form come to be ? To what processes of growth can the observed structural developments be related ? What internal and external factors determine specific structural organization ? The substance of such investigations he described as general morphology. Not only did he consider the problems of form from the physiological aspect, but he also actually carried out physiological investigations. In short, it may be claimed for him that he achieved a view of the whole field of botanical research which, within the limits of contemporary knowledge, could not well have been bettered; with suitable modifications it is one to which we might well aspire to-day.

In introducing his new point of view to a botanical world largely given over to the speculative writing inseparable from the then prevailing idealistic morphology, Hofmeister employed little general argument. Instead of this he set about the task of replacing old conceptions by new ones based on personal investigations. A clue to his general attitude is surely given in the title of his book: "General Morphology of Growing Things" (Gewächse). As Von Goebel has said: "in this book form-relations are presented as conditions of growth. This growth is investigated". Lastly, to round off our impression of the all-round 'compleat' botanist, it may be mentioned that Hofmeister interested himself in the question of variability in plants and, while demanding further studies of the influence of external factors on the conformation of organisms, he attached himself to the Darwinian theory of descent.

The Phyletic Period

As a result of Hofmeister's admirably objective inquiries and of his critical search for relationships between physiological activity and the assumption of specific form or pattern, it might have been thought that botanical science had at length been established on a broad and sure foundation, one in which morphology and physiology were seen to be inseparable aspects of the same theme. But in what has been called the phyletic period—that which followed the publication of Darwin's theory of descent—the details of plant structure, together with such facts as could be culled from the fossil record, were regarded chiefly as providing materials for comparative studies and for the construction of phylogenetic systems. The sweeping success of Darwin's views must surely have indicated to professed phylogenists that whatever comparative investigations they carried out were bound to 'fit in' somewhere, to contribute in some measure to the wonderful edifice of evolutionary theory. The facts of development and the characteristic features of the adult were thus accepted by them as purely morphological concepts, while physiological and causal aspects, though not entirely neglected, received at best little more than passing attention. But as Prof. W. H. Lang pointed out in an important review of the situation in 1915, the problems of general, that is, causal morphology, would remain even if the phyletic history were before us in full A bad feature of the phyletic period was the tendency of morphologists and anatomists to resort to facile pseudo-physiological arguments regarding the function and adaptive value of structures and organs. Meanwhile physiological research was going on its own way, out of sympathy, or out of touch, with the historic aspirations and interests of morphology.

Organization and Phylogeny

Each of the major phases in the development of botanical science has been characterized by a central idea. Thus in the Linnæan period the *beau ideal* was to know and classify as many species as possible and to add to that number by new collections from all the ends of the earth. In the Darwinian period and after, the problem of descent, which included the construction of phylogenetic systems, was the chief aim, use being made of the natural classifications which had been evolved during the preceding descriptive phase. Since the beginning of the present century, the mechanisms underlying physiological and hereditary processes have constituted leading themes. For contemporary workers in both botany and zoology the processes involved in progressive organization during development are providing problems of great importance and interest.

Now it is evident that organization could be studied as a subject *per se*, without reference to origins. But since all contemporary organisms have come from ancestors possessing greater or less family antiquity, and since the fossil record informs us that notable changes in structure have taken place down through the ages, it is clear that, whatever may be the findings from our studies of organization in contemporary organisms, such findings must also in some way be related or referable to the historic or evolutionary aspect. This, of course, is implicit in the once firmly held view that the ontogeny of any organism is a recapitulation of its phylogeny. It is apposite to note here that the modern study of organization differs from phyletic studies in that it is essentially dynamic in outlook.

The comprehensive viewpoint, therefore, will require that the results of contemporary investigations of plant organization be also considered in relation to the fossil record of past biological events. If an adequate understanding of the factors underlying the organization of living plants can be achieved, a fuller interpretation of the events indicated by the fossil record may become possible, though it can never be absolute. Whether the concepts issuing from contemporary studies of organization will support the criteria of comparison which have been used in the construction of phylogenies or will indicate that they lack validity is evidently a matter of the greatest importance and interest.

Entelechy and Holism

Since Driesch considered mechanistic conceptions of life to be inadequate he introduced the idea of a controlling or ordering principle—an entelechy—which was independent of physico-chemical laws though these were operative in living systems.

In his important work on "Holism and Evolution", General Smuts, too, considers that the explanation of living organisms cannot be purely mechanical and that mechanistic concepts have their place, and justification only within the wider framework of the integrated unity of the organism. According to him, holism—defined as the "fundamental factor operative towards the creation of wholes in the universe"—is a *vera causa*, that is, a causal factor with a real existence; in the process of evolution there is a definite and fundamental tendency towards the creation of wholes, the results becoming more marked at progressively higher levels of organic development. Thus, if we take a plant or animal as a type of a whole, "we notice the fundamental holistic characters as a unity of parts which is so close and intense as to be more than the sum of its parts; which not only gives a particular conformation or structure to the parts, but so relates and determines them in their synthesis that their functions are altered; the synthesis affects and determines the parts, so that they function towards the whole; and the whole and the parts, therefore, reciprocally influence and determine each other, and appear more or less to merge their individual characters: the whole is in the parts and the parts are in the whole, and this synthesis of whole and parts is reflected in the holistic character of the functions of the parts as well as of the whole".

Whether one agrees or disagrees with the philosophical or biological implications of holism, a valuable service has been rendered to biology by the author's insistence on the essential wholeness of organisms. In the pursuit of researches into particular aspects this integrated unity should not be forgotten.

Contemporary Aspects of Integration

A survey of certain current biochemical, physiological, genetical and morphological investigations suggests that opportunities for achieving a useful integration of data derived from these several branches do in fact exist. Admittedly the number of instances which may be cited is not great; nevertheless they constitute a beginning which may in due course be notably extended.

The marked increase of interest on the part of biochemists in isolating and determining the chemical composition and physical properties of a number of physiologically active substances is likely to prove of great importance in promoting certain aspects of contemporary botanical research. In some instances these substances, which have been comprehensively described as activators, show remarkable specificity in their action on living tissues. A number of these substances have now been synthesized; an obvious development in biochemistry is to synthesize yet others. A considerable number of physiologically active organic substances of known composition, not so far known to occur in Nature, have also been produced. Physiologists, meanwhile, have been attempting to ascertain the metabolic origin and functional relationships of naturally occurring activators. This exacting branch of plant physiology is one in which substantial progress may be anticipated in due course.

The relation of these developments to the work of the morphologist may now be considered. Morphologists are concerned with the external and internal configuration of plants and regard the facts of embryology, the development of new organs at apical growing points and the attendant differentiation of tissues as integral parts of their work. Hitherto they have laboured under a serious handicap in that they have had very few working hypotheses to account for the mechanism underlying the differentiation of new organs or of new tissues. The observed developments have been regarded as characteristic manifestations of the specific hereditary substance, or in some such generalized fashion, but hypotheses relating to the operation and interaction of individual factors have been inadequate or lacking. Hence the purely descriptive nature of much morphological work and the indefinite nature of many of the conclusions based on it. But to-day a fascinating prospect of new possibilities lies before us. For example, it is known that certain substances which the biochemist can isolate or synthesize are more or less directly involved in those all-important initial differentiations of organs and tissues, or in the subsequent growth to the adult condition. Those substances, which apparently exercise a specific morphogenetic effect, have been described by Dr. J. Needham as morphogenetic hormones. Whether or not, in the complex of factors operative in the moulding of an organ, a single substance can properly be referred to as 'morphogenetic' cannot be discussed in detail here; the important fact is that specific structural developments follow on the application of certain substances to plant and animal tissues, provided the latter are in a suitable physiological condition.

Physiologists have not only been exploring the many aspects of what may be described as general cellular physiology, they have also been investigating those difficult problems which are concerned with the movement of substances throughout the plant body. It is now known, for example, that auxins, produced at the apical growing point of the shoot, that is, the region of active formation of protoplasm, become distributed throughout the plant. Important developments ensue, for example, the inhibition of buds, promotion of root development and the progressive enlargement of tissues. Now these several developments provide the materials which the morphologist is competent to investigate and of which he wishes to render an account either in terms of comparative morphology or in explanation of how the organization or configuration observed in the adult comes to be. In short, the biochemical, physiological and morphological aspects are seen to be inextricably linked, and conjoint work is essential to any reasonably adequate account of the processes involved.

Any relationship that can be established between the hereditary constitution of an organism and the possession of those metabolites which are significant in the development of its specific morphology will represent an important advance in botanical science. Here the interests of the geneticist, the physiologist, the biochemist and morphologist become confluent. So far the instances which permit of a co-ordination of data are few in number. They are, however, of great interest, not least because they indicate the possibility of such work being extended.

In an investigation of tall and dwarf strains of maize it has been ascertained (*a*) that the difference between tall and dwarf races is referable to the action of a single pair of genes, (*b*) that the initial production of auxin, an important factor in the growth-expansion of tissues, is approximately equal at the growing points in the two races, and (*c*) that the characteristic dwarfness in one race is due to the destruction of a large part of this auxin by an oxidase not present in the tall race. Here we have a genetical observation relating to an important difference in morphological configuration, which in turn can be assigned to analysable differences in metabolic activity. When precise, co-ordinated data of this kind become cumulative, as they probably will in time, the information already gathered by morphologists and systematists may well acquire new significance and provide a new viewpoint from which to consider the central and continuous problem of evolution. Admittedly this is looking far ahead, but the goal is much to be desired.

The relation between genes and developmental processes has only recently begun to receive the attention which the subject so evidently deserves. The lack of co-ordinated development in related branches has no doubt been a contributing factor. At present very little is known about the actual physiological expression of a gene—how and where it exerts its influence: it may affect only one step in the process of development or a chain of processes; or it may be involved systemically in every aspect of development. Indeed, it is held to be improbable that any single formula will be found to unify all observations on the connexion between the influence of a gene and its results.

Biological materials in which some well-marked character is known from genetical analysis to be related to a single pair of genes seem likely to prove of great use in attempts to relate genes with developmental processes. In certain annual and biennial forms of *Hyoscyamus niger* it has been shown that if grafts of annual-flowering plants are applied to biennial stocks in their first year, flower-bud development is induced in the latter; and if the vegetative biennial scions are grafted on to annual shoots they are induced to become flowering shoots. The evidence suggests that a substance (or substances), directly or indirectly operative in flower-bud development, has passed from the tissues of the annual to those of the biennial. Now this factor, which is associated in the hereditary constitution with a single pair of genes, is productive of changes which are of profound interest to both the physiologist and the morphologist. Other instances illustrating the same community of interest relate to such characters as the shape and size of leaves, total growth, branching, difference in chlorophyll content, flower size and shape and sterility. In each, the indications are that gene-dependent diffusible substances are involved; in each the materials are such as to call for detailed physiological investigations and are of the kind on which classical systematic and morphological studies have been based.

Here, perhaps, it is appropriate to utter a word of caution. The subject-matter has been treated in such a way as to illustrate how a plurality of distinct branches of botanical science can be focused, to their mutual advantage, on the same phenomenon. But it would be a mistake to assume that the actual operational relationships involved are simple. Behind every change and development lies all the complexity inevitably associated with the multifarious operations of a metabolic system. Hence, while there is a need for simplification so that main issues and essential relationships are not obscured, the innate complexity of the processes involved should not be underestimated. Experience suggests that it is unlikely that any so-called specific morphogenetic substance is as direct in its moulding activity as the words would appear to imply. It is safer to assume that every morphological development is the result of the interaction of many factors.

To summarize briefly. The guiding lines are these: the hereditary constitution of a species, itself a small fragment of the evolutionary picture, is conceived as being subdivisible into genes; these are involved in all developmental processes; they find expression in the action of chemical substances, which in conjunction with temporal, spatial and physical factors are directly or indirectly operative in morphogenetic processes and culminate in the production of the distinctive organization of the adult.

Tissue Culture

An all-pervading consideration in biology is the physiological mechanism relating to the assumption of form, that is, to the origin of the ontogenetic growth pattern and its development to the adult status. How are we to approach this very difficult problem, and how are we to test such hypotheses as may be constructed? What, for example, are the factors leading to the institution of an apical meristem? How is it maintained in its active formative capacity? To what can we attribute the orderly development of leaf and bud primordia? What factors determine their bilateral and radial symmetry respectively and the characteristic shapes into which they are moulded during development? And the overriding 'wholeness' of the organism, what of that? These are questions on which we scarcely know how to make a beginning, for the problems are of a manifold complexity. We note that they involve the origination of cells (cytogenesis) and of organs (organogenesis)—in fact, all that is connoted by the word morphogenesis; but they also involve a great deal more.

One possible line of approach, on which a beginning if no more has been made, is by means of tissue culture. The advances made during the last thirty years in mycological and bacterial cultural methods have played an important part, and media of precise composition can be prepared on which the tissue of certain plants can be maintained in a state of growth without differentiation for an indefinite period. Here then are the means by which it may be possible to determine experimentally, on materials of known genetic constitution maintained under controlled conditions, the direct or indirect action of many factors considered to be operative in morphogenesis. Whether this hope is vain or whether it will, in fact, be realized, remains to be seen.

Conclusion

In this essay it has been quite impossible to refer to all aspects of the unification of botanical science. Studies of plant distribution, for example, which are of interest not only to the systematist, geneticist and ecologist but also to the morphologist and physiologist, have of necessity been omitted from the discussion. So, too, with taxonomy and other important branches. I have attempted to illustrate a point of view, not to cover the field.

To bring out particular points, I have referred to both conceptual and methodological aspects of unification. There are important instances where the two may be closely related. For example, the phylogenist makes use of certain morphological criteria of comparison. The validity of these criteria depends, among other things, on the accuracy of our knowledge of morphogenesis and this, on a further analysis, is seen in practice to require the conjoint work of the biochemist, physiologist and morphologist.

From the multiple-aspect-study of organization during development we not only derive some impression, however inadequate, of the organism as a whole;

we are brought face-to-face with the undeniable wholeness of the organism. A case has been made out for the view that the over-emphasis of any single aspect, while the whole is not kept in proper perspective, will almost certainly lead to the fabrication of unstable theoretical superstructures, destined to crumble because they have not been based on the fundamental reality of organic wholeness. This is a matter which concerns all botanists, though each, according to his capacity, must perform his detailed work in a particular field. But whatever that field may be, he will at one time or another be concerned with some aspect of the distinctive growth-pattern of the organism which he is investigating; this, it need scarcely be said, is of paramount interest to the morphologist at large. An interesting contrast that has been drawn between the 'substance-minded' and the 'relation-minded' man is relevant to the present discussion. "The substance-minded type of thinking," says A. H. Hersch, 1941, "is unquestionably the older, both in the individual and the race. It has all the tenacity of original sin. In morphology it has given us representative particles, preformation, the transmission of acquired characters, and such morphochemical hybrids as bristle-producing, facet-forming substances, and so on. The morphologist, when substance-minded, thinks of the developmental pattern in terms of the visible structural characteristics from stage to stage. In short, he thinks in terms of a series of pictures. But when relation-minded, the morphologist recognizes that the pattern at any moment is the expression of the events which produce it, and attempts to gain a knowledge of the durations and rates, and relative durations and relative rates of the component processes in the developmental nexus. Consequently, instead of thinking in terms of a series of pictures, the relation-minded morphologist tends to think in terms of the non-picturable. If the problem of the developmental pattern is similar to the problems of the more exact sciences, then no doubt in time a system of equations will be developed to facilitate our thinking about it".

There is the modern outlook on *one* aspect of morphology. While it is evident that certain comparative studies and all fossil studies will continue to conform to the older pattern, the new point of view suggests great possibilities for further exploration. The feasibility of pursuing these investigations to a successful conclusion will in large measure be determined by the existence of the tools to do the job. Some of these are already at hand. Here I have in mind certain major biological works recently published or reissued, for example, D'Arcy Thompson's "Growth and Form" (2nd edn.), Needham's "Biochemistry and Morphogenesis" and Child's "Problems of Pattern and Development". Each tends to emphasize a particular aspect, but taken together they afford both the morphologist and physiologist a working knowledge of the several biochemical, physical, physiological, temporal and spatial factors which, at one or another stage of development, may be operative in moulding the distinctive form of the organism.

The publication of a major work, such as any one of those mentioned above, or of a first-class text-book, is an event of rather occasional occurrence, and depends on particular individuals who possess the experience, capacity and urge to attempt a synthesis. Now, the point of view conveyed in Hofmeister's general morphology, with appropriate modernization and thereafter subject to progressive integrated development, would appear to represent a desirable central aim in botanical science with which few would disagree. With this as a focal point, it is cogent to inquire how we are to make the best use of the data of each of the special branches, having in mind the volume of such literature, the present tendency of individual workers towards intensive research in a restricted field, the fact that this may involve disability to broader vision, and the finite mental capacity of human beings. It is undeniable that the proper comprehension of the subject as a whole is suffering from the inevitable and progressive increase in specialization. How do we propose to deal with this situation ?

I claim no originality in raising this general question and offer no solution at this stage. It is evident that underlying the numerous symposia, conferences, joint-meetings and so on, that from time to time have been convened, the same or a not dissimilar point of view has obtained; but a more definite policy needs to be framed, continuously pursued and kept to the fore in our biological deliberations. The question of *how* this is to be done is for botanists collectively to decide. The time for doing so is at hand if a great opportunity is not to pass unheeded.

In conclusion, I wish to express my gratitude to colleagues for suggestions and much helpful criticism ; but for the opinions expressed responsibility lies wholly with myself.

SCIENCE AND INDUSTRY*

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CURRENT discussions as to the part which science should play in industry are often vitiated by misconceptions as to what science and the scientific activity really are. Science is not the mere use of scientific apparatus to ascertain facts, nor the use of scientific jargon to describe them. Again, we should not use the term science to include the testing of materials and the control of technical processes as practised in modern industry. All this should be regarded as part of engineering and production technique, which only incidentally requires particular kinds of apparatus and men with a particular training. Science is not primarily a matter of technique but a *specific activity of the human mind.*

The scientific activity is as definite in its character as, for example, the artistic activity or the organizing activity, and in its highest form is as rare as either.

The basic scientific processes are observation, experiment and hypothesis formation. Hypothesis formation consists in applying to observations of natural phenomena an act of creative thought, which discovers in them a meaning which they previously did not possess. This new meaning then suggests new lines of thought and new lines of observation and experiment. The essential feature is that the new hypothesis is more than an orderly presentation of the data. It is a new view of the working of Nature, which is important as much because it is new as because it is valid.

The validity of a hypothesis is a purely relative conception, for we can never know the last word about Nature, and the whole progress of science con-

* Substance of an address at the inaugural session of the North-Eastern Section of the Institute of Fuel, Newcastle-upon-Tyne, delivered on October 18.

sists in discarding an old hypothesis in favour of a new one which is more fruitful at the particular stage which the science in question has reached. A hypothesis can be termed 'valid' in so far as it fits satisfactorily a body of observed facts and enables new facts to be predicted which can afterwards be verified by experiment and observation. In other words, the hypothesis is the actual vehicle by which scientific thought is carried forward.

The essence of the scientific method is this combination of observation and experiment with the formation of hypothesis. Science is *not* the working to some predetermined plan or schedule to find an answer to a specific question. In this lies the essential distinction between science and engineering. Any industrial process or industrial development, unless it be wild speculation, must set before itself a clearly defined aim, and the industrialist must calculate in advance the material resources which he can bring to bear and the resistance which he will have to overcome. He must have an assurance of success within what is called 'a fair commercial risk'. It is upon the engineer that the industrialist relies to provide him with the technical means for carrying the project into effect. There is an element of uncertainty in every enterprise, and the task of the engineer is to reduce that element to a minimum. However bold the project may be, he must take all possible steps to ensure that the aim specified in advance is realized within a specified time, and at a specified cost.

None of these things is possible for science. Science is continually reaching out into the unknown. It cannot calculate in advance either the results which it hopes to obtain or the time which they will take to get or their cost. Any attempt to force scientific endeavour into predetermined rigid channels destroys its very essence. The result may be useful, but it is in the highest degree improbable that it will be the creation of anything new.

The whole significance of the relations between science and industry lies in this—that it is science alone which can produce new knowledge differing not merely in precision and extent, but also in *kind*, in actual quality, from that which existed before. The industrial history of the past two hundred years shows clearly where the impact of science has been truly effective. The electrical industry owes its development to the scientific work, that is the combination of experiment and hypothesis formation, of men like Faraday, Clerk Maxwell, Hertz and Röntgen. The fine chemical industry is founded on the experiments and hypothesis formation of men like Perkin, Kekulé, Fischer and Baeyer.

It is only in the present century that the attempt has been made to bring the scientific method, properly so-called, into industry as an effective part of its operations, although it should be noted that in the highly productive period between 1750 and 1900, scientific men were themselves very much interested in the practical significance of their discoveries. The new idea that there are two kinds of scientific workers to be called respectively 'fundamental' and 'applied', one concerned with the advance of knowledge for its own sake and the other with the material results of scientific work, is an artificial one and is highly misleading. The collected scientific papers of men like Benjamin Franklin, Humphry Davy, Liebig, Pasteur and Kelvin make it clear that they regarded the pursuit of knowledge and the application of knowledge as an indivisible whole. There is no suggestion of a conflict of motive in their scientific work. It has been a retrograde step in the present century to try to distinguish between fundamental and applied science or between 'pure' and 'commercial' men of science. There is only one kind of science, and that is *the observation of natural processes, the devising and conduct of experiments and the formation of hypotheses to account for the results.*

The question is sometimes asked whether there is a valid distinction between an engineer and a scientific worker. There is certainly such a distinction, for the engineer is not concerned with hypotheses, and his attitude to observation and experiment should be essentially different from that of the scientific man. The engineer's object is to make things work. He is not interested in new knowledge for its own sake. He dislikes accidents and tries to avoid being confronted with unexpected occurrences. The man of science is above all interested in the unexpected. He does not in the least mind making mistakes, providing that they teach him something. His most fertile raw material is the experiment that goes wrong, giving a result that cannot be explained in terms of existing knowledge or theories.

A survey of the elements in industrial progress would not be complete without reference to the *inventor*. The inventor belongs to a different category and must not be confused either with the scientific man or with the engineer, though of course it is possible to have inventors who by training are scientific men and inventors who are engineers. The true inventor is not really concerned with knowing *why*, like the scientific man, or knowing *how*, like the engineer. His urge is to create ; he is interested in novelty for its own sake, and he prefers to do something in a new way even if at first sight it may not offer obvious advantages over the old ways.

It is particularly important to recognize the difference in the contributions which the man of science and the inventor have to make to the progress of industry, because, on the whole, in the future, the importance of the man of science is likely to grow and that of the inventor to diminish. This is because the inventor shows to the greatest advantage where technique is primitive, and the man of science becomes more and more effective as technique is advanced.

One other misconception that needs to be removed is that 'scientific' means 'meticulously accurate'. So far from the man of science being interested in exact measurement for its own sake, he would be the first to agree that mere measurement has little value in itself. Very often rough exploratory experiments, made to find out whether things will happen in the accepted way or not, have led to far more important discoveries than a host of accurate measurements made with costly apparatus and no creative idea behind them.

To sum up, it may be stated that the true opposite of science is *empiricism*. Empiricism consists in using the results of observation and experience without attempting to understand their meaning, that is, without forming a hypothesis. A very great deal of what goes by the name of scientific research, particularly in industry, is empirical, and is therefore unlikely to lead to new knowledge and new points of view. The empirical attitude is right and indeed indispensable in the engineer, but it is wrong in the scientific worker.

With this outline of the true nature of science, attention can be turned to the question of the position of science in industry. There are essentially three partners in the enterprise of bringing a scientific discovery into general use. The first is the scientific worker who discovers the *new* piece of knowledge. The second is the engineer who combines that new knowledge with existing knowledge and experience to make something which will *work* on whatever scale may be required. Third, there is the industrialist whose judgment, powers of organization and management provide the engineer with the conditions required for his activity and convert the enterprise into what is known as *a going concern*.

These three partners do not speak the same language, and are liable to misunderstand one another in a very dangerous way in their attempts at intercourse through the medium of garbled translation. A scientific worker is apt to view with impatience the insistence of the industrialist upon the fulfilment of certain practical conditions before he is ready to bring his resources and organizing capacity to bear on a new discovery. On the other hand, the scientific man's attempt to interpret in concrete terms of commercial production what is really a new way of thinking about the world, is apt to convey either an impression of undue optimism or else of mere vagueness and muddle. Is it then the engineer who can serve as the intermediary between the man of science and the industrialist ? This would be a mistaken solution, for engineers are essentially conservative. They rightly prefer to rely on established practice or the minimum departure from it to meet the requirements of a given problem. It is the engineer's duty so far as possible to minimize risks.

The position becomes clearer when the characteristics of a successful industrialist are examined. He must have imagination and be receptive to new ideas. Above all, he must have a capacity for seeing the possibilities inherent in a situation earlier and more clearly than his competitors. He must have judgment to weigh successfully the favourable and the adverse factors in an enterprise. In other words, he must be able to see not only the possibilities but also the difficulties in a realistic way.

Now these are just the qualities which should be applied to a new piece of scientific knowledge if it is to be used rapidly to the greatest effect. It is by combining the outlook of the man of science with that of the industrialist that the significance of a new discovery can best be gauged. It is only rarely that a scientific man has also a natural capacity for industrial insight and judgment, and is able himself to direct his work into productive channels. The conclusion is therefore reached that the man of science and industrialist are natural allies. They have more in common than either usually can appreciate, but it is difficult for them to work together not merely because they speak different languages but also because they deal with different kinds of facts. Yet any industry, where the industrialists and scientific men really come together, will make technical progress of a kind that has not been seen since the beginning of the industrial epoch. This cannot be achieved by attempts on the part of the scientific workers to popularize their ideas, or by industrialists seeking to gain a smattering of science. It can only come if scientific men take the trouble to study and understand the kinds of facts which form the subject-matter of industrial activity, and also if the industrialists try to understand what is meant by the formulation of a new scientific hypothesis. Neither of these two things is so difficult as might be thought. The mistake that is made at present when the man of science tries to explain his work to industry, is that he tends to describe experiments and observations, to give numerical examples, or attempts to forecast some practical application. He does not try to convey the *meaning* of his work, the new point of view which he has reached. This is what really matters in the scientific method, for this is the true creative work which the man of science alone can do.

THE ARGENTINE EARTHQUAKE

By ERNEST TILLOTSON

ON January 15 at about 8.51 p.m. (local time) one of the strongest earthquakes of Argentine history occurred in the Andean Province of San Juan. The epicentre of the earthquake was near the chief town in the province, San Juan, which is situated at latitude 31° 38′ S., longitude 68° 38′ W., and at this place as well as in the nearby villages there was great destruction of property and loss of life. In addition to San Juan Province, the Provinces of Cordoba, Mendoza and Larioja were affected, the latter seriously. The shock was felt throughout most of the remainder of the Argentine, and also in Chile and in Uruguay. It was recorded on seismographs at many observatories throughout the world, including some in Great Britain. At La Plata it was recorded very strongly, and at Buenos Aires the recording suddenly ceased nearly as soon as it began owing to the violent, large amplitude earth waves being too great for the pendulum, which became unhinged. The recording needles of the instrument were also broken.

In San Juan, a city with a population of about eighty thousand people, about two thirds of the buildings immediately collapsed, and others were damaged in varying degrees. Among the large buildings thus affected were the cathedral, numerous churches, Government House, municipal buildings, the railway station and the post office. Fissures and fault cracks appeared in the streets. Electric cables were broken, gas mains were shattered, water pipes were burst open, and telephone communication within the city and to the outside world ceased. Roads, especially the narrow ones, were blocked with the debris of crashed buildings, and rail traffic was stopped by fissures, fallen debris and twisted rails. In the city fires raged, having been started by the shaking of hot coals from the fireplaces, by gas escapes and by electric short circuits. Even if the fire brigades could have got to them, there would have been no water supply, and so they burned themselves out unchecked. Unfortunately, at the time many people were in cafés, cinemas and restaurants and were trapped in the buildings and narrow streets. The death roll is undoubtedly high, and three thousand bodies have so far been found and burned. More than another three thousand are injured, and when the casualties in the surrounding villages are counted the death-roll may be as high as five thousand. Fortunately rail communication with Mendoza was quickly resumed, and radio communication with the city was found possible. Drinking water was sent from Mendoza, one hundred miles away. Many of the people are now living in tents and relief work is in progress. San Juan is to be completely evacuated and cleared, and when it is rebuilt it will be spacious and the buildings will be of earthquake-proof design. The evacuation would appear inevitable as aftershocks, including a very violent one some thirty-six hours after the first earthquake, caused buildings previously damaged to collapse, and damaged most of the remaining ones.

In Buenos Aires in the eastern Argentine the original earthquake was sufficiently pronounced to sway street lamps. The shock was also distinctly noticeable in the upper stories of sky-scrapers. The last strong earthquake which affected San Juan and destroyed some property occurred on October 27, 1894. On that occasion La Rioja was also affected, though the shock was not so severe as the present one. The Argentine is definitely a country where earthquakes are liable to occur from time to time, though it is not so greatly affected as its neighbour Chile. It is that part of the Argentine nearest to the Andes Mountain Chain which is most affected and not so much the eastern plains. The Andes form part of the great circum-Pacific belt of instability, round which more than half of the world's great earthquakes occur. Although earthquakes of destructive violence have happened from time to time in the twentieth century in the Argentine, they have usually been centred away from densely populated areas and towns. In the nineteenth century there were several outstandingly destructive shocks. On April 9, 1849, San Luis was destroyed. On March 20, 1861, Mendoza experienced widespread destruction, and on October 22, 1871, Jujuy and Oran suffered this same fate, to name a few outstanding examples.

NEWS and VIEWS

Sir Richard Gregory, Bart., F.R.S.

JANUARY 29 marks the eightieth birthday of Sir Richard Gregory, president of the British Association and formerly editor of NATURE. To many who have known him, this may come as a surprise, for his energy and alertness seem unabated with the passage of years. Upon his retirement from the editorship of NATURE at the end of 1938, Sir Richard gave scientific men a message which in some ways may be regarded as his own philosophy of life (see NATURE, January 7, 1939, p. 1). In it he shows his profound belief in the significance for the future of mankind of scientific progress and its application to human affairs. His labours to this end were fittingly acknowledged by his election in 1933 to the Royal Society, under the special rule which permits election to the fellowship for "conspicuous service to the cause of science".

But Sir Richard did not retire from public life when he relinquished his editorial post at the age of seventy-five ; his new leisure was quickly occupied with other interests. During the forty-five years of his association with NATURE, he had always taken a prominent part in the work of the British Association, and in particular of Section L (Education), which he served in many capacities, becoming president in 1922. Finally, at the ill-fated meeting at Dundee in 1939, which had to be abandoned through the outbreak of war, he was elected president of the British Association for 1940 (see NATURE, September 9, 1939, p. 472), and has, of course, remained in that office since. Due largely to his initiative, the Association, through the new Division for the Social and International Relations of Science, has, in spite of wartime conditions, managed to hold meetings of limited scope in Reading, Manchester, and London. Sir Richard Gregory has made many friends on his visits to South Africa (with the British Association), to India and to the United States, who will feel a particular interest as they join with other scientific men in congratulating him upon his past achievements and sending him their good wishes for the future.

Colonial Products Research Council: Report

THE first interim report of the Colonial Products Research Council states that the procedure adopted, which was modelled on and adapted from that of the Department of Scientific and Industrial Research, the Medical Research Council and the Agricultural Research Council, is to make the fullest possible use of existing research facilities in universities and other institutions, delegating to them the investigation of specific problems on terms mutually arranged. Researches already planned or initiated in this way include investigations on sucrose and sucrose derivatives under Prof. W. N. Haworth at the University of Birmingham ; on eugenol and *iso*eugenol under Prof. G. R. Clemo at the University of Durham ; on lime oil, lime juice and citrus under Prof. I. M. Heilbron at the Imperial College of Science and Technology, London ; on fixed oils and fats under Prof. T. P. Hilditch at the University of Liverpool and Dr. Ida Smedley-MacLean at the Lister Institute ; on caffeine and theobromine under Prof. A. R. Todd at the University of Manchester ; on petroleum products under Sir Robert Robinson at the Dyson Perrins Laboratory, Oxford ; and on the production of ergosterol at the Chemical Research Laboratory under Dr. A. C. Thaysen. The Council is also engaged in reviewing the field of research into vegetable drugs. The Director of Research has been accommodated at the Imperial Institute by the courtesy of Sir Harry Lindsay. While the function of the Council is to organize and sponsor fundamental and applied researches on Colonial commodities, with the primary object of finding new uses for them, the Institute will continue its chemical investigations of Empire raw materials in accordance with its statutory obligations and will furnish information to producers and potential customers on sources of supply, markets, the preparation of commodities for commercial and industrial use, and the economic possibilities for any given commodity, etc.

The Education Question : a Biological Approach

THE inaugural address at the University of Leeds School of Medicine delivered last autumn was by Sir John Graham Kerr, who announced as his subject "Medicine and Education". To what extent the substance of the address answered the expectations of the audience is perhaps doubtful, but there is no doubt whatever that it answered to one of the needs of the hour. Sir John pointed out that, among primitive peoples, a boy becomes a highly trained observer by eye and ear, he acquires the ability to interpret rapidly and correctly what he observes and he learns to keep his wits constantly alert. As boyhood passes into adolescence, he accompanies his elders on their expeditions, and his education continues as before. That the education of to-day has departed so widely from its original type is, added Sir John, due, paradoxically, to one of the most beneficent events in the history of our civilization—the invention of the printed book, which brought with it the possibility of mass education. An inevitable result of the domination of education by the printed book was the reduction to a position of relative unimportance of that training in observation, judgment and mental alertness which formed so important a part of education in the earlier phases of communal evolution. In the child's pre-school life, we still have that kind of training, as also in later adult life of vocational employment. But in the intervening period of school life, the boy becomes in the main an absorber of information obtained from the printed page. The remedy lies not in further overloading the school curriculum, but in correcting some of the existing wastage. As to girls' education, Sir John, believing it to be a question for the women of the country, declined to commit himself, except to say that the education of a girl should be permeated with the realization that the highest ideal of her sex is that of home and family.

Higher Education in the Caribbean

THE Commission on Higher Education in the Colonies (see NATURE, August 21, 1943, p. 211) has appointed a committee of its members, and co-opted representatives from the West Indies, with the following terms of reference: "To review existing facilities for higher education in the British colonies in the Caribbean and to make recommendations regarding future university development for these colonies." The committee is constituted as follows: Sir James Irvine (chairman), vice-chancellor of the University of St. Andrews; Prof. A. M. Carr-Saunders, director of the London School of Economics and Political Science; Miss Margery Perham, reader in Colonial administration at the University of Oxford; Dr. R. E. Priestley, vice-chancellor of the University of Birmingham; Mr. P. Sherlock, secretary of the Institute of Jamaica; and Mr. H. Springer, member of the House of Assembly, Barbados; with Mr. T. R. Rowell, assistant educational adviser at the Colonial Office (secretary). The committee will spend some three months visiting Jamaica, Trinidad, Barbados and British Guiana. Mr. W. D. Inniss, lately assistant master at Queen's Royal College, Trinidad, will serve on the committee while it is in Trinidad, and Mr. J. A. Luckhoo, member of the Executive and Legislative Councils, British Guiana, while it is in that colony.

An Idealist View of Special Publications

IN a paper "Streamlining Production and Distribution of Current Periodical Articles" (*Special Libraries*, 34, No. 6, July–August 1943), Zeliaette Troy, librarian of the Boyce Thompson Institute for Plant Research, after directing attention to the difficulties which the present system of publication offers to individuals as well as to libraries, and to the drawbacks of inter-library loans, film copies and photostat copies, suggests a scheme for minimizing the mechanics of publication and distribution. Under this scheme, an author would complete his article and send it to the usual editors, by whom, on approval, it would be sent to a central printing office. There the manuscript and abstract would be stamped with the date of receipt, and the authorizing organization indicated. When the article and abstract are in printable form, they would receive a common chronological number, followed by a classification number, after which the cost accountant would put a price on the article and on the abstract in accordance with the number of copies to be printed, and both items would go to the printing establishment.

The printers would thus supply a stream of scientific articles uniform in size, with the author, title, name of the organization sponsoring and paying for it, the date of receipt, the master number and the classification number or numbers. They would also supply a periodical index and abstract journal issued both in its entirety and by subject sections. Members of a subscribing organization would receive one copy each of the publications authorized by it. Individuals or libraries subscribing for all articles in certain classifications would be similarly supplied. The index-abstract journal would have an annual paid subscription charge both for the complete issue and its sections.

The advantages of the proposed system to the individual, in the absence of delays in publication and in being sure of seeing all articles on the subjects falling within the classifications for which he subscribes, in the relief from the burden of proof-reading and the distribution of proofs are clearly indicated, and the failure of the individual to distinguish between his working tools and his 'browsing' literature is emphasized: the latter might well be left to his library, and only those articles of fundamental and immediate importance to him taken into his private collection. Libraries would have the further advantages of being relieved of inter-library loans and expensive and inadequate reproductions. Binding problems would be simplified and some binding could be eliminated.

Geological Society: Medal Awards

THE Council of the Geological Society announces the following awards: Wollaston Medal to Prof. V. M. Goldschmidt, professor of geology, Frederiks University and Museum, Oslo, for his outstanding contributions to Norwegian petrology, and his fundamental researches into the structure of crystals and the distribution of the chemical elements in the earth; Murchison Medal to Prof. V. C. Illing, of the Imperial College of Science and Technology, for his talented contribution to oil geology and Palæozoic stratigraphy; Lyell Medal to Dr. N. R. Junner, of the Geological Survey of the Gold Coast and Sierra Leone, for his contributions to the stratigraphy of the Pre-Cambrian and his discoveries of valuable minerals associated therewith; Wollaston Fund to Mr. A. G. Brighton, curator of the Sedgwick Museum, Cambridge, for his services to palæontology and his researches on the echinoderms; Murchison Fund to Mr. G. M. Stockley, of the Geological Survey, Tanganyika Territory, for his work on the stratigraphy, palæontology and mineral resources of East Africa; one moiety of the Lyell Fund to Dr. S. Buchan of the Geological Survey of Great Britain, for his work on underground water resources of the London area; another moiety of the Lyell Fund to Mr. E. W. J. Moore, of Haslingden, for his researches on carboniferous goniatites.

Presidency of the American Chemical Society

PROF. C. S. MARVEL, professor of organic chemistry in the University of Illinois, has been elected president of the American Chemical Society for 1945. Prof. Marvel will take office as president-elect on January 1, 1944, when Dr. Thomas Midgley, jun., vice-president of Ethyl Corporation, and known for his discovery of tetraethyl lead, becomes president, succeeding Dr. Per K. Frolich, director of the Chemical Division, Esso Laboratories, Standard Oil Development Company, Elizabeth, New Jersey. Dr. Marvel was recently awarded the 1944 William H. Nichols Medal of the New York Section of the American Chemical Society. He has made outstanding contributions to research on the structure of vinyl polymers, used as synthetic plastics, particularly in the production of transparent aircraft parts, as rubber substitutes, and as thickening and blending agents in the chemical manufacturing industry. He has also made important researches on the structure of polymers of sulphur dioxide and olefines, and has developed practical methods for preparing amino-acids.

Wind and Bird-Migration

DR. NORMAN H. JOY (*Field*, Dec. 11, 1943) has published a short account of observations on bird-migration maintained almost continuously for four years at Dungeness, on the coast of Kent. This is useful work, of a kind not often undertaken so intensively. He has, in particular, noted the conditions of departure across the English Channel in autumn. As only selected observations are given, it is difficult to make a critical assessment of the conclusion that birds of certain species, for example, swallows, leave only when there is a contrary wind. The frequency with which birds are seen migrating against the wind has often been remarked. To some extent the impression may be exaggerated—birds flying across the wind (as Dr. Joy points out) have to head partially into it to correct their drift; and birds flying against the wind, at reduced speed in relation to the ground, remain longer under notice. In any event, it is open to question whether the relation between wind and a migratory movement is one of cause and effect, or whether they have a common origin in the general meteorological situation. Dr. Joy's suggestion that birds find a head wind advantageous because it gives them more lift is untenable: once it is airborne, a bird can derive no lift from the body of air within which it moves (assuming, for simplicity, that the current is horizontal and of uniform strength), except as a result of its own air speed.

Poisonous Reptiles of the World

THE Smithsonian Institution "War Background Studies", No. 10 is on the poisonous reptiles of the world, by Doris M. Cochran (Smithsonian Inst., 1943). It contains brief accounts of all the principal poisonous reptiles arranged in geographical groups, namely, the United States, Latin America, Europe and northern Asia, India and Malaya, Africa and Australia, New Guinea and the South Pacific Islands. The brochure is illustrated with seventeen plates, the first of which is coloured and most of which contain two species. There is also a small selected bibliography and an appendix dealing with first aid treatment, the preparation of antivenin and directions to collectors. From it medical officers should be able to identify any of the ordinary poisonous reptiles with which they are likely to be concerned even without previous knowledge of the group. It is obvious also that it will be useful to others than to those for whom it is particularly written.

Fishes from Philippine Seas

HENRY W. FOWLER has described many new fishes in his recent paper "Contributions to the Biology of the Philippine Archipelago and Adjacent Regions. Descriptions and Figures of New Fishes obtained in the Philippine Seas and Adjacent Waters by the United States Bureau of Fisheries Steamer *Albatross*" (U.S. National Museum, Bull. 100, 14, part 2. Smithsonian Institution, 1943). These belong to several families and form an appendix to the detailed reports on these groups of *Albatross* fishes. There are ten new genera, one new sub-genus, one new sub-family and twenty-two new species in this paper. Many of these fishes are of striking form, notably *Calliurichthys lineathorax* n.sp., with its enormously long caudal fin as long as all the rest of the fish. All the illustrations are excellent.

The Night Sky in February

FULL moon occurs on Feb. 9d. 05h. 29m. U.T., and new moon on Feb. 24d. 01h. 59m. The following conjunctions with the moon take place: Feb. 3d. 06h., Mars 7° N.; Feb. 4d. 07h., Saturn 3° N.; Feb. 9d. 11h., Jupiter 0·4° S.; Feb. 21d. 20h., Venus 1° S.; Feb. 22d. 20h., Mercury 1° S. The following occultations of stars brighter than magnitude 6 take place: Feb. 4d. 22h. 58·6m., 57 Ori. (*D*); Feb. 5d. 03h. 23·6m., 64 Ori. (*D*); Feb. 7d. 18h. 36·7m., d^1 Canc. (*D*); Feb. 7d. 23h. 43·0m., θ Canc. (*D*); Feb. 17d. 06h. 01·1m., η Lib. (*R*). The times refer to Greenwich and *D* and *R* refer to disappearance and reappearance respectively. Mercury rises at 6h. 28m. at the beginning of the month and at 6h. 44m. at the end of the month, and is too close to the sun to be favourably seen. Venus rises a little before 6h. throughout the month and is a conspicuous object in the morning hours. Mars can be seen through a good portion of the night, setting at 3h. 57m., 3h. 26m., and 2h. 56m. at the beginning, middle and end of the month. Jupiter is in opposition on Feb. 11 and can be seen throughout the night, setting at 8h. 21m. and 6h. 20m. at the beginning and end of the month. Saturn is a little east of Mars and sets about 15 minutes later than Mars in the middle of the month. At the beginning and end of the month Saturn sets at 4h. 35m. and 2h. 42m. The planet is stationary on Feb. 20.

Announcements

WE regret to announce that Dr. W. W. C. Topley, F.R.S., secretary since 1941 of the Agricultural Research Council, and formerly professor of the division of bacteriology and immunology in the University of London, died on January 21, aged fifty-seven.

THE Council of the Royal Aeronautical Society has elected Group Captain F. Whittle a fellow of the Society; such an election is a special distinction in recognition of work of great importance in aeronautics.

MR. ATTLEE, Lord President of the Council, has announced that the Government has appointed the following committee to consider and make recommendations as to the development of television after the War: Lord Hankey (chairman); Sir Noel Ashbridge and Mr. Robert Foot, B.B.C.; Sir Raymond Birchall and Sir Stanley Angwin, General Post Office; Mr. Harvey, Treasury; Sir Edward Appleton, Department of Scientific and Industrial Research; and Prof. J. D. Cockcroft, Ministry of Supply.

LETTERS TO THE EDITORS

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

Fluorescence as an Aid to Physiology

THE great value of fluorescence as a guide to physiological activities was first brought home to me in 1925, when I observed that cod-liver oil which had been exposed to sunlight had lost its fluorescence. Following up this simple observation, I found that the loss of fluorescence was accompanied by the loss of vitamin A[1]. The value of fluorescence in the search for pure chemical carcinogens was proved by Kennaway and Hieger[2], who used the fluorescence of carcinogenic fractions of tar as a guide, which eventually led to the identification of benzpyrene, though the first pure chemical carcinogen identified by them was 1 : 2 : 5 : 6-dibenzanthracene, which they suspected of being carcinogenic on the strength of its fluorescence and absorption spectra.

During the past eighteen years, I have repeatedly made use of fluorescence in a variety of experiments the primary purpose of which was related to cancer, but in the course of such work I have repeatedly noted observations of physiological interest, some of which have been described in journals devoted to cancer research and thus not likely to excite interest among those concerned mainly in experimental physiology. It seems possible that some of these observations might be of interest apart from their bearing on cancer, and, in this hope, I should like to place them on record.

(1) As a method of demonstrating the great speed at which substances can travel in the blood stream, I know of nothing so striking as a fluoroscopic examination of blood collected drop by drop from one ear of a rabbit during the period of injection into a vein of the opposite ear of a colloidal suspension of benzpyrene or anthracene, every particle of which is brilliantly fluorescent. In this way, it is possible to demonstrate that the maximum speed of circulation is much greater than one would estimate from experiments in which dyestuffs are injected, as the sensitivity of the fluorescent method is enormously greater than that of colorimetric methods. Many fluorescent substances can readily be detected in dilutions of more than one in a million, and, in the case of colloidal suspensions, in far higher dilution.

(2) The rapidity with which such fluorescent particles disappear from the circulating blood (within fifteen minutes) led to the observation of the mechanism of elimination of hydrocarbons, which has been published in detail elsewhere[3], and illustrated, incidentally, a beautiful method of visualizing part of the mechanism of excretion by the liver. This is so striking and so easily demonstrated that one would think it must be of interest to those who teach students about the physiology of the liver. The change from the colloidal state to true solution, in the liver, and the metabolism to the hydroxy-compound can also be visualized clearly in the case of benzpyrene, owing to the different coloured fluorescence seen in different stages of the process. The subsequent excretion in the bile demonstrates the rate of secretion and excretion of the fluid, and can also be used to show peristaltic waves passing along the intestine and the rate of movement of its fluid contents. Moreover, it can be shown that in the case of chicks *in ovo* the gall-bladder does not contract ; so the bile with which it is filled remains non-fluorescent after intravenous injection of fluorescent substances, while the hepatic ducts and intestine stand out in striking contrast, by reason of their content of fluorescent bile. In the newly hatched chick, however, as soon as it begins to peck food or even eggshell, the gall-bladder contracts and rapidly fills with fluorescent bile, thus demonstrating that contraction of the gall-bladder is related to the presence of food in the alimentary canal. Some of these observations have been published[4].

(3) Recently, I have observed a striking and peculiar appearance in the cæcum of a mouse following a fluorescent meal. Fluorescence of the organ in this animal showed a sharp line of demarcation dividing it axially into fluorescent and non-fluorescent parts, the fluorescence being limited to the concave half of the organ. Although I have repeated this experiment a few times, I have not again killed an animal at the precise time at which this phenomenon could be observed, suggesting that it is only of very temporary duration, but possibly throwing light on the method of action of this organ.

(4) As a last example, I should like to cite what, for want of a better name, I have termed 'loop-way' excretion by the liver of substances that are finally excreted by the kidney. This can be beautifully illustrated by injecting mice intravenously with 1 per cent fluorescein solution, and killing them at intervals up to one hour or more after injection. It will be seen in such experiments that the liver and kidney simultaneously excrete the dye, so that it is voided in the urine at the same time that it is being excreted into the bile and so into the intestine. As this substance is readily diffusible, it is rapidly reabsorbed from the intestine, while renal excretion continues to lower the blood level of the substance. In this way, finally, it is all excreted in the urine. Thus, if one limited the experiment to observations on the amount injected and the amount excreted in the urine, no evidence would be obtained of the important loop-way action of the liver in lowering the blood level. Many other substances, including indigo carmine, used in renal efficiency tests, can be shown to follow the same route in animals with experimental biliary fistulæ.

Some of these observations have appeared, as stated above, in journals not devoted to physiological experiments ; others have not been published at all. I am not primarily concerned with physiological experiments, and so cannot devote time to pursuing them as far as I could wish. It is possible that such effects are already well known to some physiologists ; but I believe that this is not generally true and that it is not widely appreciated how very easy the detection of fluorescent substances in the animal body can be. The only apparatus required is a source of ultra-violet rays, screened by Wood's glass, and a dark room in which observations can be made by an observer whose eyes are adapted to the dark.

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Function of Carbonic Anhydrase in Blood

CARBONIC anhydrase, which catalyses the reversible reaction

$$CO_2 + H_2O \rightleftarrows H_2CO_3,$$

is an intracellular enzyme found in high concentration within red blood corpuscles[1]. The activity of this enzyme and the kinetics of the reactions it catalyses have been studied mainly either with laked corpuscles or with hæmoglobin-free enzyme preparations. Suspensions of intact corpuscles tested by the usual colorimetric or manometric methods were found to be almost completely inactive. The activity of carbonic anhydrase within the red blood corpuscles, as well as its relationship to the chloride shift, were demonstrated spectroscopically by Keilin and Mann[2]. They used for this purpose red cells in which hæmoglobin had been oxidized to methæmoglobin; the latter acting as an indicator changing its colour and absorption spectrum with the pH of the surrounding medium. The activity of carbonic anhydrase was determined by them from the velocity of these changes in presence and in absence of sulphanilamide, which they found to be a highly specific inhibitor of this enzyme[3].

The present communication summarizes the results of experiments which demonstrate that the uptake and liberation of carbon dioxide can be catalysed by the carbonic anhydrase present within normal intact red blood corpuscles.

The experiments on the velocity of carbon dioxide uptake were carried out as follows: 20 ml. of horse blood or of a suspension of corpuscles are put in a 350 ml. flask, carefully evacuated and equilibrated with pure nitrogen or pure oxygen. 10 ml. of this blood is introduced through one of the apertures into a 250 ml. Woolf bottle filled with a gas mixture containing 5 per cent carbon dioxide in nitrogen or in oxygen. The bottle is fixed to a stationary shaking apparatus and its second aperture is connected by means of a three-way tap to the manometer. When the temperature is equilibrated, the taps are closed and the bottle is violently shaken and the manometer is read every 15 seconds. The same procedure was adopted for the study of the liberation of carbon dioxide, the only difference being that the blood was first equilibrated with the gas mixture containing 5 per cent carbon dioxide and then transferred to the Woolf bottle containing pure nitrogen or pure oxygen.

The results of these experiments, which are shown in Fig. 1 (A and B), can be summarized as follows: (1) The velocities of either the uptake or the liberation of carbon dioxide are markedly decreased by the addition of a small amount of sulphanilamide, but are not affected by sulphapyridine, which confirms the previous observations by Mann and Keilin[3] as to the effects of these drugs on carbonic anhydrase. (2) Although sulphanilamide decreases the velocities of these reactions, it has no effect on the equilibrium point, which is ultimately reached and which depends only on the total buffering capacity of the sample tested. In fact, by extrapolation Curve 4 will meet Curve 1. (3) Sulphanilamide will thus differentiate the buffering capacity of corpuscles from their catalytic activity, both of which influence the velocities of carbon dioxide uptake and liberation. (4) The slowness of carbon dioxide uptake or liberation by serum alone after the first minute of the reaction is partly due to its low buffering capacity. (5) In all these experiments the velocity of carbon dioxide liberation was lower than that of uptake. This may be due to the state of oxygenation of hæmoglobin. However, further experiments are

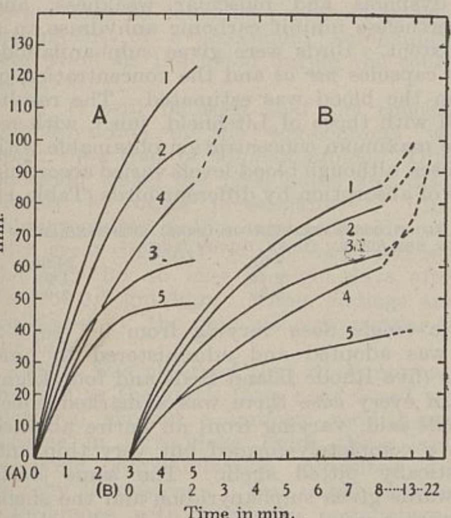

FIG. 1.

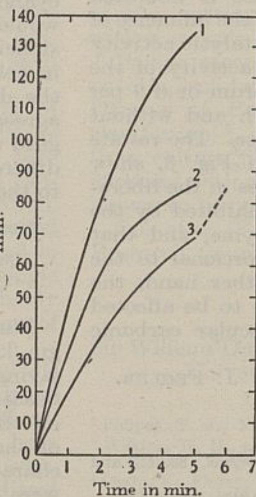

FIG. 2.

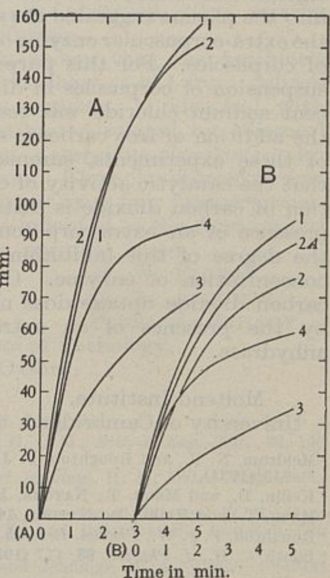

FIG. 3.

FIG. 1. UPTAKE (A) AND LIBERATION (B) OF CARBON DIOXIDE BY RED BLOOD CORPUSCLES SUSPENDED IN A MIXTURE OF SERUM AND SALINE 1 : 1.
(1) 50 per cent blood corpuscles; (2) 30 per cent blood corpuscles; (3) 10 per cent blood corpuscles; (4) 50 per cent blood corpuscles + 0·15 per cent sulphanilamide; (5) the serum-saline mixture without blood corpuscles.

FIG. 2. UPTAKE OF CARBON DIOXIDE BY RED BLOOD CORPUSCLES.
Washed 3 times with 0·2 M phosphate, pH 7·3, and suspended in (1) mixture of 6 per cent glucose and 0·9 per cent sodium chloride (2) 6 per cent glucose; (3) 6 per cent glucose + 0·15 per cent sulphanilamide.

FIG. 3. UPTAKE (A) AND LIBERATION (B) OF CARBON DIOXIDE BY RED BLOOD CORPUSCLES SUSPENDED IN A MIXTURE OF SERUM AND SALINE, 1 : 1.
(1) 50 per cent blood corpuscles; (2) 50 per cent blood corpuscles + 0·4 ml. conc. sol. of carbonic anhydrase; (2A) 50 per cent blood corpuscles + 0·1 ml. conc. sol. of carbonic anhydrase; (3) the serum-saline mixture alone; (4) the serum-saline mixture + 0·4 ml. concentrated sol. of carbonic anhydrase.

required for an adequate explanation of this phenomenon.

The relationship between the activity of carbonic anhydrase and the chloride shift was postulated by Roughton[4] and demonstrated by Booth[5] and by Keilin and Mann[2]. This was confirmed in the course of the present investigation. As shown in Fig. 2, the activity of the red blood corpuscles washed in isotonic phosphate solution and suspended in 6 per cent glucose solution is much lower than the activity of these corpuscles suspended in glucose solution which was diluted with an equal volume of 0·9 per cent sodium chloride. The activity of corpuscles in absence of sodium chloride was not, however, completely abolished, since it is still higher than that of the same suspension poisoned with sulphanilamide.

The fact that on hæmolysis of the red blood corpuscles, which may occur under certain pathological conditions, carbonic anhydrase is liberated into the plasma suggested the study of the influence of the extra-corpuscular enzyme on the catalytic activity of corpuscles. For this purpose the activity of the suspension of corpuscles in diluted serum or 0·9 per cent sodium chloride was tested with and without the addition of free carbonic anhydrase. The results of these experiments, summarized in Fig. 3, show that the catalytic activity of corpuscles in the liberation of carbon dioxide is distinctly inhibited by the presence of an extra-corpuscular enzyme, and that the degree of this inhibition is proportional to the concentration of enzyme. On the other hand, the carbon dioxide uptake does not seem to be affected by the presence of an extra-corpuscular carbonic anhydrase.

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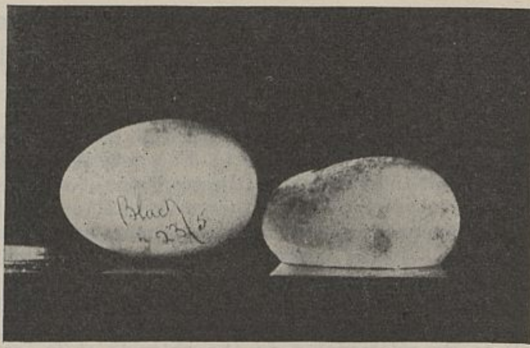
Carbonic Anhydrase, Sulphonamides and Shell Formation in the Domestic Fowl

Meldrum and Roughton[1] were the first to advance the hypothesis that carbonic anhydrase might play a part in egg-shell formation by influencing the rate of formation of the anion of calcium carbonate by catalysis of the reaction $CO_2 + H_2O = H_2CO_3$. Following up this suggestion, Common[2] examined the tissues of the hen's oviduct for their carbonic anhydrase activity, and concluded "that the carbonic anhydrase activity of the uterine epithelium is higher than that of the remaining oviducal tissues, and that this activity may play a part in shell secretion". On the other hand, it has been demonstrated by Keilin and Mann[3] that compounds of the RSO_2NH_2 type (where R is a benzene, naphthalene or pyridine ring) specifically inhibit carbonic anhydrase in very small concentrations. This property, however, is absent in all such compounds in which the sulphonamide group is substituted, as it is, for example, in sulphapyridine or sulphathiazole.

With these findings in mind, we administered representative compounds of the unsubstituted and substituted RSO_2NH_2 type to laying hens, in order to investigate their effect on shell secretion. It was



first necessary to ascertain an appropriate dose, which would not produce any of the undesirable symptoms of sulphanilamide poisoning such as cyanosis, dyspnœa and muscular weakness, and would nevertheless inhibit carbonic anhydrase to a sufficient extent. Birds were given sulphanilamide in gelatine capsules *per os* and the concentration of the drug in the blood was estimated. The results agreed well with those of Litchfield, jun.[4], with regard to the maximum concentration obtainable with different doses, although blood-levels varied according to the rate of absorption by different birds (Table 1).

TABLE 1. BLOOD CONCENTRATION OF (FREE) SULPHANILAMIDE IN MGM./CENT. (DOSE, 0·1 GM./KGM.)

Birds	6 hr.	24 hr.
1	2·46	4·92
2	5·48	2·90

Finally, a single dose varying from 0·1 to 0·2 gm./kgm. was adopted and administered to nine laying hens (five Rhode Island Reds and four Light Sussex). In every case there was a marked effect on the shells laid, varying from an entire absence of shell to a completely formed but very thin and characteristically pitted shell. The same birds were afterwards given sulphapyridine and the shells obtained were normal throughout. In the photograph are shown two eggs, laid by the same hen, the shell-less one being laid when the hen was receiving sulphanilamide and the normal one when it was being given sulphapyridine.

It should be emphasized that throughout these experiments the birds showed no ill-effects whatsoever, and their appetite and laying capacity seemed unimpaired.

The concentrations of free and acetylated sulphanilamide and sulphapyridine in the homogenized egg-contents were determined, wherever possible, using Mawson's[5] modification of Werner's method. Some of the results are given in Table 2.

TABLE 2. CONCENTRATION OF SULPHONAMIDES IN THE EGG-CONTENTS IN MGM./CENT. (i = free; ii = acetyl)

a. Sulphanilamide

Birds	Days after dosing 1		2	
	i	ii	i	ii
3	1·64	7·75	0·36	2·42
7	3·54	10·01	0·68	1·76

b. Sulphapyridine

Birds	Days after dosing 1		2		3		4	
	i	ii	i	ii	i	ii	i	ii
5	0·70	1·06	0·56	1·63	0·38	0·65	—	—
6	0·52	0·56	—	—	0·86	0·05	0·23	0.11

Birds	Days after dosing 5		6		8	
	i	ii	i	ii	i	ii
5	0·35	1·19	0·50	—	—	—
6	0·46	1·30	—	—	0·19	—

The following points emerge from these experiments: (1) Acetylation in the hen is pronounced, which again confirms the findings of Litchfield. This does not, however, interfere with the purpose of the experiments, since acetylation takes place at the para-amino group and the total amount of active sulphonamide group remains undiminished.

(2) The inhibitory action of sulphanilamide on carbonic anhydrase is completely reversible, bearing out the observations of Keilin and Mann in their *in vitro* experiments. The effect on shell formation disappeared completely after all the sulphanilamide had been eliminated. Moreover, a graded effect on the shells was observed after the usual single dose. Thus, the shells laid on successive days showed a diminishing effect which was correlated with the decreasing concentration of sulphanilamide in the egg-contents (Table 2*a*). It was also noted that the effect on the shells laid by any one bird depended upon the time which elapsed between dosing and laying. The most marked effect was observed after a period such as could be presumed to permit of the attainment of a maximum sulphanilamide concentration in the blood during the course of shell secretion.

(3) It will be seen that the concentration of sulphapyridine in the egg-contents was always lower than that of sulphanilamide. This is a phenomenon which has been noted and discussed previously by other investigators[4,6]. In addition, sulphapyridine, unlike sulphanilamide, was excreted with great difficulty by the fowls, and was found in the eggs for so long as eight days after a single dose of 0·2 gm./kgm. These findings are probably explained by the very poor glomerular function of the fowl[4,6].

(4) It was observed that while normal egg-shells (as well as the shells from hens dosed with sulphapyridine) showed a uniform reddish-purple fluorescence in ultra-violet light, those laid by hens receiving sulphanilamide presented an uneven, blotchy fluorescence. This might be due to direct interference with porphyrin metabolism or to an irregular deposition of calcium porphyrinate, in line with the faulty shell secretion as a whole.

It therefore appears that carbonic anhydrase is essential for shell formation in the domestic fowl, for which purpose the anion of the calcium carbonate seems to be of equal importance with the cation. Thus, interference with normal anion production by way of the mechanism suggested may provide the explanation for the well-known phenomenon of pathological production of soft-shelled eggs by hens adequately supplied with calcium in a suitable form.

We are indebted to Messrs. May and Baker, Ltd., for the generous gift of sulphonamides.

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Claviformin from *Aspergillus giganteus* Wehm.

THE production of a penicillin-like substance from *Aspergillus giganteus* has been described[1]. Wilkins and Harris[2] noted that this mould produced a different antibiotic when grown in a different medium, namely, dextrose 4 per cent, $NaNO_3$ 0·1 per cent, KH_2PO_4 0·1 per cent. When tap water was substituted for distilled water, production of the antibiotic was slower but the final yield greater. The mould was harvested after 4–8 weeks incubation. The active material was concentrated by adsorption on charcoal, extraction with amyl acetate and finally extraction with ethyl acetate. On concentrating and cooling this extract, crystals of active material were obtained the properties and appearance of which at once suggested that the antibiotic was identical with claviformin[3]. It had a melting point of 109° C., and no depression of the melting point was observed after mixing with a sample of claviformin.

It has recently been shown that the antibiotic patulin, isolated by Birkinshaw *et al.*[4] from culture filtrates of *Penicillium patulum*, is identical with claviformin[5,6]. The antibiotic isolated by Wiesner[7] from culture filtrates of *Aspergillus clavatus* is also identical with claviformin[6]. Thus claviformin is now known to be produced by at least four fungal species.

One of us (F. J. P.) is indebted to the Agricultural Research Council for a personal grant.

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Use of Casein Hydrolysate in Experiments on the Nutrition of *Lactobacillus casei*

FOR some considerable time work has been going on in these laboratories on the nutritional requirements of *Lactobacillus casei*. Besides the known vitamins of the B-complex there are at least two other factors involved. These are present in the water-soluble portion of whole liver, and endeavours are being made to purify and isolate these active components.

During this work difficulty has been encountered as the active fractions become more purified, owing to the removal of other necessary nutritional requirements. It has always been appreciated in these laboratories that results using casein hydrolysate were not comparable to those given by pure amino-acid media, and prior to 1939 all work on microbiological nutrition was carried out on media of known composition. Owing to war conditions and the difficulty of obtaining adequate supplies of pure amino-acids, it has become necessary to work so far as possible with a medium based on casein hydrolysate, prepared according to the directions of Mueller and Johnson[1]. When this is used as a source of amino-acids, it is found that besides the addition of tryptophane and cystine, the presence of leucine and *iso*leucine gives a considerable improvement in the growth and acid production obtained (cf. Happold[2] on the necessity of *iso*leucine in toxin production by *C. diphtheriæ*). An increase of 15–30 per cent in acid production has been noted. The relative insolubility of these amino-acids makes it probable that they are readily removed both from the casein hydrolysate and from the liver fractions.

On further purification, liver concentrates are obtained, for which the activity is improved by the addition of threonine. As an example it may be quoted that the activity adsorbed on, and eluted from, dialysed iron, requires threonine added to the medium. In some cases an increase in growth of up to 60 per cent has been recorded. Even with the addition of leucine, *iso*leucine and threonine, the blanks were completely negative, while with some of the more active liver concentrates, an acid production of 25 ml. 0·1 N. per 20 ml. medium has been obtained.

Consequently, when protein hydrolysates are used as the basis of media for assay work on the nutrition of *L. casei*, it is considered advisable to determine the threshold optimum for the addition of these amino-acids to the medium employed. Normally they are added to the media used in these laboratories at a level of 0·01 per cent (w./v.). (1·0 ml. of a 1 per cent solution to a litre of medium.)

We wish to thank Messrs. Roche Products, Ltd., for a grant to this department, enabling us to carry out these investigations.

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Origin of the Solar System

SIR JAMES JEANS[1] returns to his original form of the tidal theory, in which the sun at the time of disruption was distended beyond the orbit of Uranus. As I was responsible for the modification that required the sun to have had approximately its present size at the time, perhaps my reasons may be restated.

There appears to be no astrophysical evidence that stars of the mass of the sun can have anything like the distension required by Jeans's theory. This might possibly be met on Lane's law by the low rate of radiation of a star at such distension, supposing it still gaseous; if there were such stars, they would probably be invisible. But I do not see how my mechanical objection can be met. We should have to provide an explanation of how the orbits of the planets could be reduced to their present sizes. They would still have to miss the sun on their first perihelion passage to avoid re-absorption; and nothing but a resisting medium seems capable of reducing the mean distances. But then we meet a dilemma. Either the medium would be revolving at nearly the same rate as the planets and would have no effect on their mean distances, or it would revolve more slowly and its density would be too small at large distances to produce any appreciable effect.

The time-scale affords a further difficulty. The age of the earth appears to be limited to 3×10^9 years at the outside, and if this datum is combined with the mass-luminosity relation, it leads directly to the result that the sun could not have been much larger than at present.

I think that the most serious difficulty of all catastrophic theories, affecting both Jeans's theory and mine, and also Lyttleton's further modification, is that the newly formed planets would need to be able to control not only the velocities of thermal agitation but also those of general expansion due to the sudden relief of pressure. I have offered some suggestions about this, but am not particularly satisfied by them. Low temperature does not appear to help.

What seems to me particularly important in the present state of the subject is to have some idea of the vapour pressures of ordinary solids at temperatures far below their boiling points. It seems clear that the majority of satellites and asteroids could not have condensed from the gaseous state under gravitation alone. But if the temperature was low enough for the saturation pressure to fall below the actual pressure, condensation would take place anyhow. If this was true in Jeans's distended star, the star would consist of dust instead of gas. In the later development of planets and satellites we have to consider densities of a resisting medium of the order of 10^{-15} gm./cm.^{3} at temperatures ranging from 100° to 400° absolute. If the density was above that of saturated vapour at the temperature considered, there would be accretion, and satellites could grow no matter how small they were; if not, their gravitational attraction would never produce more than an atmosphere. I think that the data required could be calculated, but have not been able to find them in any work that I have consulted.

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[1] NATURE, **149**, 695 (1942); **152**, 721 (1943).

THE theory outlined by Dr. H. Alfvén[1] appears to overlook an essential factor in the problem of astronomical evolution. At the present time the distance of the planet from the sun is determined by the fact that it possesses a certain endowment of energy and angular momentum.

If the scattered material from which Jupiter is assumed to have been evolved was initially endowed with this angular momentum, then any effect produced by electromagnetic forces must be regarded as purely temporary and is therefore irrelevant to the main issue. On the other hand, if it is suggested that the angular momentum was acquired during the process of condensation, it is necessary to describe and explain the mechanism by which the transfer of angular momentum was effected. If the angular momentum cannot be accounted for, the theory breaks down.

If it is assumed that the galaxy consisted originally of a cloud of scattered material in the form of gas, dust and small solid particles, and that the stars, planets and satellites have been evolved by a process of condensation from this material, then an adequate theory of astronomical evolution must explain three things: (1) why the angular momentum of the solar system is so much less than the angular momentum of an equal mass of the original cloud; (2) why the angular momentum (per unit mass) of the sun, referred to the centre of the system, is so much less than that of the planets; and (3) why the angular momentum (per unit mass) of a planet, such as Jupiter, referred to the centre of the planetary system, is so much less than that of its satellites.

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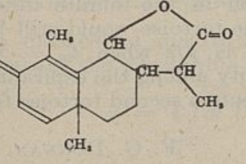
[1] NATURE, 152, 721 (1943).

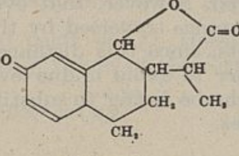
A Case of Total Asymmetric Synthesis

WE have recently announced a successful synthesis of santonin (I)[1]. We believed then that it was racemic. We have since found it to be optically active. The synthetic specimen has a rotation of $[\alpha]_D = -150$ add m.p. 171°. Sodium santoniate prepared from this sample was fractionally precipitated as the strychnine salt. This salt on decomposition gave santonin with $[\alpha]_D = -172$ identical with the rotation of natural santonin. The filtrates gave another product with identical m.p. (171°) and rotation $[\alpha]_D = -108$, which was not changed on further fractional precipitation by strychnine or quinine hydrochloride, but in no case was a dextro-rotatory product obtained. So far as we are aware, this is the first total asymmetric synthesis, apart from asymmetric synthesis carried out in the presence of polarized light, etc.

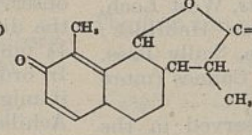
We have also prepared compounds II, III, IV and V. It has been found that asymmetric synthesis occurred only in those compounds (I, IV and V) which had an angular methyl group. The others were racemic and could be resolved into *d*- and *l*-forms through their strychnine salts.



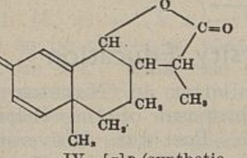
I



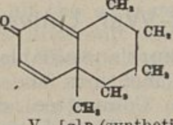
II *d*-form $[\alpha]_D = +112$
l-form $[\alpha]_D = -112$



III *d*-form $[\alpha]_D = +158 \cdot 4$
l-form $[\alpha]_D = -158 \cdot 35$

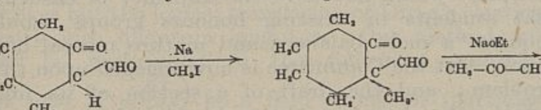


IV $[\alpha]_D$ (synthetic specimen) $= -108$

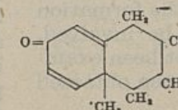


V $[\alpha]_D$ (synthetic specimen) $= -55 \cdot 65$

We have also determined the stage at which the asymmetric synthesis occurs by carrying out the synthesis of V by the following reactions:



VI (Inactive) VII (Active)



V (Active)

VII is an unstable liquid and cannot be purified by distillation, and also its solid derivative could not be prepared. However, the crude substance had an optical rotation $[\alpha]_D = -26 \cdot 22$. The corresponding methylated formyl derivative used in the synthesis of santonin could not be examined for optical activity as it was highly coloured. Methylation of the formyl cyclohexanone or the corresponding derivative appears to be the stage at which the asymmetric synthesis occurs.

All rotations have been determined in chloroform solution at 28° C.

Further work is in progress.

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Poona, 2.
Nov. 13.

[1] *Current Science*, 12, 153 (1943).

Aerial Disinfection

THE letter from workers at the National Institute of Medical Research[1] was of interest to us, as we also find that lactic acid is an effective bactericidal aerosol, when the test organism is *C. xerosis*, emulsified in sterile saliva.

Bechhold[2] long ago advocated the use of hydroxy and carboxylic acids as germicidal aerosols. We found cinnamic and benzoic acids (both constituents of Peru balsam[3]) to be strong aerial bactericides, but acids, such as citric, fumaric, maleic, malic and phthalic tested recently proved relatively ineffective. On the other hand, maleic and phthalic anhydrides were found to be more active than their corresponding acids. In a concentration of 4 mgm./m³. and a relative humidity of about 60 per cent, maleic anhydride generally sterilized the air of our test organism within five minutes; the durability of lethal effectiveness being good, a 15-minute old mist only allowing survival of some 5 per cent of the bacteria beyond the 5-minute exposure time.

As regards the amount of germicide necessary to sterilize or nearly sterilize the air of our test organism within 5 minutes, it was found that of fifteen phenolic compounds examined, each required the vapour concentration to be of the order of 25 per cent saturation. Saturation at 20° C. was calculated from the vapour pressures deduced from the formula of Clausius and Clapeyron (which can be expressed as $\log p = A + B/T$, where A and B are constants). Other substances, for example, mercuric chloride, propylene and diethylene glycols, apparently require to be of an approximately similar concentration. Notable exceptions are iodine and maleic anhydride (below 1 per cent), suggesting that the mechanism of the lethal effect here is different from that of the phenols. It will thus be understood that while we see no reason to alter our opinion[4] regarding the fundamental importance of the vapour pressure of phenols in relation to activity on air-borne bacteria, it appears that this particular characteristic is not a reflexion of the activity of all groups of substances. Again, we do not consider water solubility an essential characteristic, seeing that the fifteen phenols tested varied greatly in this respect.

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A. H. BAKER.
C. C. TWORT.

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South Street, Portslade,
Sussex. Jan. 6.

[1] NATURE, 153, 20 (1944).
[2] British Patent No. 472,623 (1935).
[3] *J. Hygiene*, 41, 121 (1941).
[4] *J. Hygiene*, 40, 342 (1940).

Occurrence of Strontium in Molluscan Shells

ATTENTION was recently directed to the possible role of small quantities of strontium carbonate in promoting the formation of aragonite, rather than calcite, in certain molluscan shells[1]. At that time the presence of traces of strontium had been demonstrated in only a few species of bivalves with aragonite shells (namely, *Tellina tenuis*, *T.* (*Macrotoma*) *baltica* and *Donax vittatus*), while the absence of strontium from some examples of the calcite shell of *Ostrea edulis* was also recorded.

I have lately had an opportunity of examining spectroscopically the occurrence of strontium in a number of other shells. It may be useful to record these results. The presence of strontium has been noted in the aragonite shells of the following species: *Venus gallina*, Gower, South Wales; *Lutraria elliptica*, Clyde; *Ceratisolen legumen*, South Wales; *Arca tetragona*, Naples (traces only); *Mactra stultorum*, South Wales (traces only); *Tellina fabula*, Aberdeen (traces only); *Cyprina islandica*, Clyde; *Pholas crispata*, ? Clyde; *Tapes aureus*, West Loch, Tarbert; *Dentalium entalis*, ? Inner Hebrides; *Nautilus* sp.; *C. edule*, Fairlie, Clyde, Scilly Isles, South Wales (traces only); *C. edule*, Cannes (more distinct).

No evidence of strontium was observed in the following aragonite shells: *Cardium echinatum*, Clyde; *Nucula tenuis*, Clyde; *Unio* sp., New Zealand; *Dreissensia polymorpha*, canal at Possil, Glasgow.

No evidence of strontium was obtained in the calcite shell *Anomia ephippium* from the Clyde. Slices of two species, *Mytilus edulis* from the Clyde, and *Pecten varius* from the Clyde, which include layers of both calcite and aragonite were examined, the layers being crushed together. No trace of strontium was obtained in either species.

It may be concluded that small traces of strontium are commonly found in shells consisting of aragonite, but that its occurrence is not universal, and though it may be one of the factors leading to the formation of aragonite, other factors must also be involved. Comparatively few calcite shells have yet been examined, but no evidence of strontium has been obtained in any of them.

My thanks are due to Prof. E. Hindle and Mr. R. Elmhirst for some of the material examined, and to Prof. J. W. Cook for facilities for spectroscopic examination.

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[1] Trueman, E. R., *J. Roy. Mic. Soc.*, 62, 69 (1942).

Achilles and the Tortoise: a Variant

ZENO's famous paradox might perhaps be used in the following way to enliven young aspirants condemned to listen to a bald narration of the peculiar virtues of the exponential function. Assuming Achilles to give the tortoise a flying start of 10 units and to move always ten times as fast as the tortoise, every schoolboy (untroubled by the infinite divisibility of space and time that formed the basis of Zeno's argument) knows that Achilles will overtake the tortoise when the latter has moved $1\frac{1}{9}$ units from its starting-point, and that this result is independent of the absolute and constant speeds of Achilles and the tortoise. Now for the enlivenment (?). Let us suppose that both Achilles and the tortoise suffer from immediate and continuously increasing fatigue, in such a manner that $v_T = pe^{-\lambda t}$, $v_A = 10pe^{-\lambda t}$. It will be observed that the initial ($t = 0$) speeds are p and $10p$ respectively, and that Achilles *always* moves ten times as fast as the tortoise (p and λ are finite positive constants, t denotes time from the start, and the suffixes A and T refer to Achilles and the tortoise respectively). Supposing Achilles to give the tortoise a flying start of 10 units, and t_m to be the time interval from the flying start when Achilles overtakes the tortoise; then

$$10p\int_0^{t_m} e^{-\lambda t}dt - p\int_0^{t_m} e^{-\lambda t}dt = 10.$$

This equation reduces to $e^{-\lambda t_m} = \dfrac{9p - 10\lambda}{9p}$, so that $t_m = \infty$ if $9p = 10\lambda$ or $\lambda = 0{\cdot}9p$. Hence, if the latter relation holds between the constants λ and p, Achilles will, in ordinary language, never overtake the tortoise. It will be observed, however, that even in the infinite limit, the distance traversed by the tortoise would still be $1\frac{1}{9}$ units, since this distance is p/λ when $t_m = \infty$. In order to avoid undue levity among the aspirants, it might be better to substitute a second tortoise for Achilles.

F. G. DONNAN.

The Athenæum,
London.

Post-War University Education

MR. HARDIE's valuable letter in NATURE of January 8 mentions the proposal of the British Association Committee on Post-war University Education that English universities should offer, in addition to the existing specialized Honours Schools, a general honours course in "philosophy, natural and social". Mr. Hardie truly observes that the new discipline would not solve the difficulty of ensuring that students in existing honours groups should acquire "a more balanced and mature mental outlook". But the Committee is now engaged upon this problem; and the draft of a section of its final report, suggesting how the problem might be solved, is to be considered at the next meeting of the Committee. This draft has a good deal in common with Mr. Hardie's own proposal.

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AN UNAMBIGUOUS METHOD OF AVOIDING DIVERGENCE DIFFICULTIES IN QUANTUM THEORY

By PROF. E. C. G. STUECKELBERG
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THE classical theory of a point charge and the quantum theory of wave packets contain in their usual form well-known divergences. Dirac[1] has elaborated a classical particle theory which avoids these difficulties, but his results cannot as yet be applied to quantum theory. On the other hand, Heisenberg[2] has recently proposed a new formalism which permits the calculation of collision cross-sections in quantum theory without being disturbed by diverging terms. However, no connecting link such as the correspondence principle has been given in order to apply this quantum formalism to a given problem such as Rutherford scattering, Compton effect or radiation damping.

Dirac's theory being well known, we content ourselves with recalling briefly the general idea of Heisenberg's description of collision phenomena. If no reaction between particles takes place, the behaviour of the system of particles can be described by a plane wave in configuration space $\Psi^{(0)}$. Such a wave can always be decomposed into an incoming $\Psi^{(0-)}$ and an outgoing $\Psi^{(0+)}$ spherical wave. If reactions take place, the number of particles scattered in a given direction (as observed by an observer at infinite distance from the collision region) is determined by a change of phase in the outgoing wave. This effect is described by a unitary phase operator $e^{-i\eta}$ determining the true outgoing spherical wave $\Psi^{(+)} = e^{-i\eta}\Psi^{(0+)}$ at infinity. The operator η must be Hermitic and relativistically invariant. Applying the method to quantized fields $u(\vec{x},t)$, Heisenberg discusses the effects due to η values of the form

$$\eta = \varepsilon \int_{-\infty}^{+\infty} dt \int (dx)^3 \, u\left(\vec{x},t\right)^n .$$

If u is written as a series
$u = \Sigma\, (2Vk^4)^{-\frac{1}{2}} (a_k \exp(i(k,x)) + a_k^* \exp(-i(k,x)))$
with $(k,x) = (\vec{k},\vec{x}) - k^4 t$, $k^4 > 0$, the operator η has to be chosen so that all the a^*'s stand left of all the a's. This rule is invariant and prevents singularities from occurring. The space-time integral guarantees the invariance of the formalism and implies the usual conservation laws of energy (k^4) and momentum $\vec{k}$. No description for finite distances is possible in this theory.

We have succeeded in connecting the usual quantum theory to the Heisenberg formalism, and the result is but the logical translation of Dirac's classical theory into quantum language. Our method will best be understood in the following example:

Let $u(x) = u\left(\vec{x},t\right)$ be a field of matter (particles) the wave packets of which follow the same world-lines $x^a = q^a(\lambda)$ as the particles do. If $m\,\ddot{q}_a = \varepsilon\partial\varphi/\partial q^a$ is the differential equation of the corresponding particles in a given field of force $\varphi\left(\vec{x},t\right)$,

$$(\Box - (m^2 - 2\varepsilon m\varphi))\, u = 0 \qquad (1)$$

is the wave equation. The reaction on the field φ is described by

$$(\Box - \varkappa^2)\,\varphi = -\rho;\ \rho = \varepsilon m u^2;\ (\text{or } = \varepsilon \int d\lambda\, \delta(x - q(\lambda))) \quad . \quad (2)$$

In quantum theory we treat both u and φ as operators, developing them into series with a_k^*, a_k (for u) and b_μ^*, b_μ (for φ). Thus, the explicit time dependence of u and φ is given by $(\Box - m^2)u = (\Box - \varkappa^2)\varphi = 0$, while the true time derivative $\dot{u}$ follows from a canonical formalism

$$\dot{u} = \frac{\partial}{\partial t} u\left(\vec{x},t\right) + i\varepsilon\left[H(t), u\left(\vec{x},t\right)\right];$$
$$\varepsilon H(t) = \varepsilon m \int (dx)^3 \varphi u\left(\vec{x},t\right)^2 \qquad (3)$$

This expression (3) and the explicit time dependence of the operators are equivalent to (1) and (2). In order to apply our theory to an actual problem, we have to express the Schrödinger probability amplitude $\Psi(t)$ in terms of the probability amplitude $\Psi(-T)$ at a time $t = -T$ before the collisions have occurred ($\lim T = \infty$). Quantum theory proceeds as follows: the Schrödinger differential equation

$$\frac{\partial \Psi(t)}{\partial t} = -i\varepsilon\, H(t)\, \Psi(t) \qquad (4)$$

is solved by successive approximations in ε. We try, however, the solution

$$\Psi(t) = e^{\alpha(t)}\, \Psi(-T). \qquad (5)$$

Substituted into (4), it leads to the integral equation $(\partial\alpha/\partial t \equiv \dot{\alpha})$

$$-iH(t) = \dot{\alpha}(t) + \frac{\varepsilon}{2!}[\alpha, \dot{\alpha}] + \frac{\varepsilon^2}{3!}[\alpha,[\alpha,\dot{\alpha}]] + \ldots \qquad (6)$$

In order to obtain a solution for the unknown operator $\alpha(t)$ ($\alpha(-T) = 0$), we develop $\varepsilon\alpha$ in the following series $\varepsilon\alpha = \varepsilon\alpha^{(1)} + \varepsilon^2\alpha^{(2)} + \varepsilon^3\alpha^{(3)} + \ldots$

The first terms are

$$\begin{aligned} \varepsilon\dot{\alpha}^{(1)} &= -i\varepsilon H(t) \\ \varepsilon^2\dot{\alpha}^{(2)} &= -\frac{\varepsilon^2}{2}[\alpha^{(1)}, \dot{\alpha}^{(1)}] \equiv \varepsilon^2 \alpha \overset{(2)}{R} + \varepsilon^2 \alpha \overset{(2)}{C} \\ \varepsilon^3\dot{\alpha}^{(3)} &= -\frac{\varepsilon^3}{2}[\alpha^{(2)},\dot{\alpha}^{(1)}] - \frac{\varepsilon^3}{6}[\alpha^{(1)},\dot{\alpha}^{(2)}] \end{aligned} \qquad (7)$$

etc. Integrating from $-T$ to t and applying the usual commutation rules ($[u(x), u(y)] = iD(x-y)$), the first terms are

$$\varepsilon\alpha^{(1)} = -i\varepsilon m \int_{-T}^{t} dt \int (dx)^3 u^2 \varphi\left(\vec{x},t\right)$$

$$\varepsilon^2 \alpha \overset{(2)}{R} = -i\frac{\varepsilon^2}{2} m^2 \int_{-T}^{t} dt \int (dx)^3 u\left(\vec{x},t\right)^2 \text{ret}_{(\varphi)}(u^2) \qquad (8)$$

$$\varepsilon^2 \alpha \overset{(2)}{C} = -i\varepsilon^2 m^2 \int_{-T}^{t} dt \int (dx)^3 u\varphi\left(\vec{x},t\right) \text{ret}_{(u)}(u\varphi)$$

$$\varepsilon^3\alpha^{(3)} = -i\varepsilon^3 m^3 \int_{-T}^{t} dt \int (dx)^3 (u\left(\vec{x},t\right)^2 \text{oper}(uu\varphi) + \ldots).$$

$\text{ret}_{(\varphi)}(\rho)$ is the retarded potential of a charge density ρ in (2), oper (ρ) is another more complicated integral operator. After developing u and φ in terms of the a,a^* and b,b^* operators, we can, as did Heisenberg, interchange their order so as to have all a^*,b^* left of the

a,b. This change corresponds to an invariant subtraction of all diverging terms; the term $a^*_{k''}a_{k'}\,a^*_{k'}\,a_k$ in $\alpha_C^{(2)}$ contributes to the 'Coulomb' self-energy of the u-particles. The other terms of $\varepsilon^n\alpha^{(n)}$ correspond to the transition-probabilities for collisions in which $n + 2$ particles take part (in the sense of chemical reactions). For example, $\varepsilon^2\alpha^{(2)}_R$ contains the term $a^*_{k'''}a^*_{k''}a_{k'}a_k$, where two particles with the momenta k and k' disappear and two particles of momenta k'' and k''' are created. This is Rutherford scattering (if φ is the electromagnetic field) and $\varepsilon^2\alpha^{(2)}_C$ contains the Compton effect ($a^*_{k'}b^*_{\mu'}a_kb_\mu$), where a φ-quantum of momentum μ collides with a u-particle of momentum k. The terms in $\varepsilon^3\alpha^{(3)}$ contain the *Bremstrahlung* ($a^*_{k'''}a^*_{k''}\,b^*_\mu a_{k'}a_k$), where, in addition to the Rutherford scattering, a μ-quantum is created.

Putting $t = +T$ and passing to $T \rightarrow \infty$, our theory takes the Heisenberg form. However, we have unambiguously determined the Hermitic Heisenberg operator $\eta = i\varepsilon\alpha(\infty)$ and, furthermore, for any given t, we can describe the quantum mechanical state of the system.

We can arbitrarily change the numerical coefficients of each individual $\varepsilon^n\alpha^{(n)}$ (or of their invariant parts) without destroying the conservation laws or the invariance. For example, a theory which contains only $\varepsilon\alpha = \varepsilon^2\alpha^{(2)}R$ and nothing else shows Rutherford scattering but no radiation effects (no Compton effect and no *Bremstrahlung*, etc.). But such a theory is possible even classically. Consider a system of particles, where the force acting upon any one of them is the mean value between the advanced and retarded effect of all other particles. Such a theory is invariant and conserves energy and momentum, but it is not conformal to our causal representation of phenomena. The same acausal behaviour is contained in the quantum mechanical $\Psi(t)$. There exists now a finite probability that a quantum appears at a certain event $(\vec{x},t)$, without a finite probability that a cause has occurred at a preceding event in the invariant past of $(\vec{x},t)$. In electrodynamic phenomena, the causal behaviour has been experimentally checked. Therefore, our theory is unambiguous if applied to quantum electrodynamics. Applied to nuclear forces, however, we have great liberty in the choice of $\varepsilon\alpha$ (or of Heisenberg's η) if we go back to a causal description at small distances. But one must say that it is not necessary to go back to causal description even for distances of 10^{-13} cm.

We have applied our theory to the case of line width. A classical point particle with an internal (scalar) degree of freedom (τ, ρ, σ) treated according to Dirac's method leads to

$$\ddot{\tau} + \frac{1}{2\pi}\,\varepsilon^2\mu_0\sigma\dot{\tau} + \mu_0{}^2\tau = \varepsilon\sigma\,\varphi\,(q(\lambda))^{\text{inc}};\ \dot{\sigma}\sim 0.$$

Its line broadening due to radiation damping is (if $\sigma = +1$ and $\varkappa = 0$) therefore

$$J(\mu) = \gamma^2((\mu - \mu_0)^2 + \gamma^2)^{-1};\ \gamma = \frac{\varepsilon^2}{4\pi}\mu_0. \qquad (9)$$

The corresponding quantum mechanical model is given by two fields of matter u and v the rest masses of which differ by $m_v{}^2 - m_u{}^2 \cong 2m\mu_0$. With $\varepsilon H = 2\varepsilon m\int(dx)^3uv\varphi$, only particles of mass $m_u(< m_v)$ are stable (analogous to $\sigma = +1$ in classical theory). Excitation of the u-particle into the v-state and subsequent emission of a φ-quantum, or the dispersion of a φ-wave produces φ-quanta of frequency μ with a probability given by

$$J(\mu) = \left(\sin\frac{\gamma}{\mu-\mu_0}\right)^2;\ \gamma = \frac{\varepsilon^2}{4\pi}\mu_0 \qquad (10)$$

instead of (9). This is a rigorous solution of the quantum-mechanical problem. The approximate treatment of Wigner and Weisskopf[3] leads to (9). Total intensity of the emitted light and the dispersion for $|\mu - \mu_0| \gg \gamma$ are, however, the same.

[1] Dirac, *Proc. Roy. Soc.*, A, **167**, 148 (1938).
[2] Heisenberg, *Z. Phys.*, **120**, 513 and 673 (1943).
[3] Weisskopf and Wigner, *Z. Phys.*, **63**, 54 (1930).

BEHAVIOUR OF THE SONG SPARROW AND OTHER PASSERINES

MRS. NICE is well known to ornithologists as an indefatigable and scientific observer, whose previous detailed studies on the song sparrow (*Melospiza melodia*), published in 1937 as vol. 4 of the *Transactions of the Linnæan Society of New York*, had shed new light on the detailed behaviour of particular individuals of a particular bird species in Nature, as well as extending our general ideas on the territory theory. In a second work* she brings together under their various heads the behaviour traits of the song-sparrows she has watched in Nature and those she has hand-reared herself (all her observations concern colour-banded and therefore individually recognizable individuals), together with a vast amount of data on other species from the recent literature. Thus we have here one of the first essays in the comparative study of avian behaviour.

The result is of great value. Methodologically it is of interest as a crowning demonstration of the fact that field observation, if properly carried out, is an essential tool of biological science: laboratory research could never have elicited the facts and principles here set before us. It is also a reminder for the average biologist that the principles of vertebrate behaviour are now emerging with some clarity, thanks very largely to the labours of field ornithologists, and that they are in many ways unexpected and of great general interest.

It is impossible in the space available to give a critical review, and I must confine myself to citing some of the chief topics covered by Mrs. Nice, with the reminder that in each case she gives a balanced discussion of her own and others' findings.

These topics include an attempt to disentangle innate and acquired factors in bird behaviour (which leads to somewhat surprising results); a general discussion of Lorenz's basic theories of *releaser* or *signal* stimuli, and of the role of the *Kumpan* (or fellow-member of the same species) in the social life of birds; an account of the genetic psychology of passerine birds from hatching onwards; waking and sleeping times in relation to twilight; a discussion of the dominance and subordination relations of passerines; 'symbolic' actions; song; territory; habitat selection; a general analysis of the difficult problems of pair-formation; courtship; injury-feigning; enemy recognition; individual variation in behaviour.

* "Studies in the Life History of the Song Sparrow (2). The Behavior of the Song Sparrow and other Passerines". By Mrs. M. M. Nice. (*Trans. Linn. Soc., N.Y.*, **6**, Sept. 1943, pp. viii+329.)

In regard to this last point, Mrs. Nice makes it clear that every individual male song-sparrow has his own repertoire of songs, all of them readily distinguishable, with a little practice, from those of all other males. The number of separate songs in a cock bird's repertoire varies from six to twenty-four. One male song-sparrow sang from 4.45 a.m. to 7.43 p.m., giving 2,305 songs in fifteen hours, with 278 songs as his highest rate per hour !

Again (as Lack has since shown in the English robin) migration is a matter of individual variation ; and indeed birds that migrate one year need not do so the next.

There are a few criticisms to be made. Among several misprints (including some, such as the transposition of lines on p. 64, which one does not expect to find in a scientific publication), there is one serious one in Table 13 where *songs* should apparently be *song-series* ; and in Table 5, the "group V" discussed in the text is omitted. Although a great volume of literature is comparatively reviewed, there are some curious and unexplained gaps. Thus, though Lloyd Morgan's fundamental "Habit and Instinct" and Kirkman's recent important studies on egg and nest-site recognition are cited in the literature list, they appear to be neglected in the discussion. The important work of Lockley on homing and other activities in shearwaters is entirely omitted, together with the numerous data of various authors on the behaviour of the gannet, and the valuable work of Nicholson and Koch, complete with gramophone records, on the song of British birds. More generally, the sections on courtship and display might have been fuller, with more weight given to studies on other forms, notably non-passerines.

These, however, are mere minor omissions. The work as a whole is a monument of industry and a model of method. If the author appears to go a little far in claiming (p. 273) that "the study of animal behavior is the only and ultimate source of understanding ourselves", it is certainly true that it is an indispensable aid in that task, and further that it reveals unexpected aspects of mental evolution which even the most complete study of our own psychological organization could not have made available. In any event, in this and the preceding work, Mrs. Nice has made a massive and outstanding contribution to our advancing knowledge of animal behaviour. JULIAN HUXLEY.

OX BLOOD FOR BLOOD TRANSFUSION

MANY people must have wondered whether some use could not be made of the large quantities of ox blood available in our slaughter-houses. If the conclusions drawn by Dr. Edwards (*Brit. Med. J.*, Jan. 15, 1944) and his collaborators survive the further tests to which they are being subjected, the ox of the future may not only give his life and meat for man, but may serve him also with his very blood and may be kept for that purpose by the community.

The use of plasma for surgical treatment is, as Dr. Edwards points out, increasing rapidly, and the search for a suitable plasma other than that provided by the blood banks is in progress. It would seem that the collaboration between Dr. Edwards and the Regional Transfusion Laboratories, the North Staffordshire Royal Infirmary and experts at Cambridge and Liverpool, has gone a long way towards the solution of this problem. The substitutes for human plasma which have been tried have not, Dr. Edwards states, possessed the three characteristics that are necessary, namely, that they should be retained in the circulation and should eventually be metabolized, that they should exert an osmotic pressure equivalent to that of the plasma and that they should be non-toxic, free from antibodies and non-antigenic. Bayliss in 1916 tried 6 per cent gum acacia in saline for the treatment of shock, but this was only partially metabolized and much of it remained in the tissues with unpleasant consequences. Other substances mentioned by Dr. Edwards may maintain the blood-pressure in shock and hæmorrhage, but they do not restore the blood protein. Animal plasma protein most nearly resembles human plasma protein, and the total protein of bovine blood most nearly approaches that of human blood ; but it contains a much higher percentage of fibrinogen. Further, its albumin/globulin ratio is lower, so that bovine blood might exert a lower osmotic pressure, because the albumin fraction exerts the greater pressure. Bovine blood is, however, available in practically unlimited quantities.

It has been shown that crude bovine serum is unsuitable. Dr. Edwards outlines the attempts to overcome such difficulties as the serum sickness which it causes and the tendency to hæmolysis of the human red cells and the slow rate of administration. He explains in detail the method which he and his collaborators have finally adopted for the preparation of a bovine serum which has been tested on twenty-six cases. The method includes the heating of the serum to 72° C. to destroy the antibodies and the addition of 0·2 per cent of formalin and ammonia to render the proteins uncoagulable. He claims that the serum obtained fulfils the requirements indicated above.

The final product is called D.B.S. (despeciated bovine serum). It has an osmotic pressure comparable to that of filtered human plasma. It was kept for six months in Dr. Edwards's car and was then given to a patient without untoward results ; after nine months in a refrigerator it had not deteriorated. It can, moreover, be given very rapidly and in large amounts. After a preliminary trial on twenty-six patients, Dr. Edwards claims that it is safe to give it to man and that it is well retained in the circulation. It is easily prepared in large quantities.

The possibility of the transmission by it of tuberculosis or of *Brucella abortus* has been considered. Dr. Edwards advocates bleeding from tuberculin-tested stock only ; or only from bullocks and heifers, because only 6 per cent of these coming to the slaughter-house are infected with tuberculosis or *Brucella abortus*, whereas the rate among slaughtered cows is 30 per cent. If the meat inspector reports gross tuberculous infection of the carcass, the blood taken from that animal should be discarded. But the Seitz filtration during the process of manufacture should, Dr. Edwards thinks, remove any of these organisms that may be present in the blood.

Before he gives a final judgment, Dr. Edwards wisely awaits the results of more detailed hæmatological and biochemical work on the effects of the administration of despeciated blood serum to patients in states of shock, hypoproteinæmia and protein deprivation and loss. G. LAPAGE.

FORTHCOMING EVENTS

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

Saturday, January 29

ROYAL PHOTOGRAPHIC SOCIETY (SCIENTIFIC AND TECHNICAL GROUP) (joint meeting with the ASSOCIATION FOR SCIENTIFIC PHOTOGRAPHY) (at 16 Princes Gate, South Kensington, London, S.W.7), at 2.30 p.m.—Symposium on "Micro-densitometry and Micro-sensitometry".

Tuesday, February 1

INSTITUTE OF FUEL (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 2.30 p.m.—Mr. Harold Moore: "Liquid Fuels and Organic Chemicals from Coal and Home-Refined Petroleum".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Prof. H. D. Kay: "Modern Developments in Dairy Science", ii. "Milk Production and Livestock Problems".*

INSTITUTION OF CIVIL ENGINEERS (ROAD ENGINEERING DIVISION) (at Great George Street, Westminster, London, S.W.1), at 5.30 p.m.—Mr. R. U. Law: "Modern Plant and Road Construction".

Wednesday, February 2

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr. E. C. Goldsworthy: "Light Alloys in Post-War Britain".

Thursday, February 3

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 2.30 p.m.—Sir Lawrence Bragg, F.R.S.: "The Strategy and Tactics of Crystal Structure Analysis by X-Rays".*

KING'S COLLEGE (in the Department of Electrical Engineering, Strand, London, W.C.2), at 3 p.m.—Mr. W. D. Horsley: "Turbo Generator Practice".*

Friday, February 4

SOCIETY OF CHEMICAL INDUSTRY (MANCHESTER SECTION) (joint meeting with the NORTHERN BRANCH OF THE INSTITUTE OF PETROLEUM) (at the Grand Hotel, Aytoun Street, Manchester), at 2.30 p.m.—Dr. F. King: "Petroleum Refining—a Chemical Industry".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5 p.m.—Prof. E. D. Adrian, O.M., F.R.S.: "Brain Rhythms".*

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at the Mining Institute, Newcastle-upon-Tyne), at 6 p.m.—Mr. S. Booth: "The Electrical Equipment of Ships".

Saturday, February 5

NUTRITION SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 10.30 a.m.—Conference on "Budgetary and Dietary Surveys of Families and Individuals", Part 1.

GEOLOGISTS' ASSOCIATION (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Sir Edmund O. Teale: "The Geology and Scenery of Tanganyika Territory, East Africa".

INSTITUTE of PHYSICS (MANCHESTER AND DISTRICT BRANCH) (at the Christie Hospital and Holt Radium Institute, Wilmslow Road, Withington, Manchester), at 2.30 p.m.—Prof. W. V. Mayneord: "Physical Principles of X-Ray Therapy".

APPOINTMENTS VACANT

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

ORGANIZER OF AGRICULTURAL EDUCATION—The Secretary for Education, County Hall, Ipswich (February 1).

ASSISTANT HORTICULTURAL OFFICER (temporary)—The Executive Officer, Berkshire War Agricultural Executive Committee, 1 Abbot's Walk, Reading (February 4).

ASSISTANT (temporary) TO THE ADVISORY BACTERIOLOGIST—The Secretary, Edinburgh and East of Scotland College of Agriculture, 13 George Square, Edinburgh (February 5).

LECTURER IN CHEMISTRY—The Clerk and Treasurer, Dundee Institute of Art and Technology, Bell Street, Dundee (February 5).

PRINCIPAL of the Gloucestershire College of Domestic Science and Training College—The Secretary, County Education Office, Shire Hall, Gloucester (February 5).

CHIEF TOOL DESIGNER for service in an Admiralty Establishment in Scotland—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.1965.A.) (February 9).

METALLURGIST AND CHEMIST in a large general purpose Iron Foundry and Engineering Works in the North Midlands—The Ministry of Labour and National Service, Central (Technical and Scientific) Register, Advertising Section, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. O.N.F.1932.XA) (February 9).

LECTURER IN PHYSIOLOGY—The Registrar, King's College, Newcastle-upon-Tyne (February 9).

REGISTRAR—The Principal, University College of Wales, Aberystwyth (February 10).

TUTOR IN NATURAL SCIENCE—The Principal, Lady Margaret Hall, Oxford (February 10).

HEAD OF THE DEPARTMENT OF CHEMISTRY AND BIOLOGY of Leeds College of Technology—The Director of Education, Education Office, Leeds 1 (February 12).

INSTRUCTOR (temporary) IN TECHNICAL SUBJECTS at the Hull Nautical School and School for Fishermen—The Director of Education, Education Offices, Guildhall, Hull (February 14).

RADIOGRAPHER in charge of the X-Ray Department and PRINCIPAL of the School of Radiography—The House Governor, King's College Hospital, Denmark Hill, London, S.E.5 (February 14).

ENGINEERING LECTURER (Ref. No. C.1997A), MATHEMATICS LECTURER (Ref. No. A.422A), PHYSICS LECTURER (Ref. No. A.423A), ASSISTANT MATHEMATICS AND PHYSICS LECTURER (Ref. No. A.424A), ENGINEERING INSTRUCTOR (Ref. No. O/N.391), and a DEMONSTRATOR to assist lecturers in class work generally, for the Technical School of a Government Department located in Surrey—The Ministry of Labour and National Service, Central (Technical and Scientific) Register, Advertising Section, Alexandra House, Kingsway, London, W.C.2 (quoting the appropriate Ref. No.) (February 16).

CHAIR OF BOTANY tenable at King's College, and CHAIR OF BOTANY tenable at Birkbeck College—The Academic Registrar, University of London, c/o Richmond College, Richmond, Surrey (February 21).

LECTURER IN CHEMISTRY FOR MEDICAL STUDENTS—The Acting Secretary, University Court, Glasgow (February 25).

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).

TECHNICIAN to undertake routine preparation of slides and to assist in research in the Department of Physiology—Prof. Burns, Medical School, King's College, Newcastle-upon-Tyne, 2.

PHYSICAL-CHEMIST to work on Adhesives, and a PHYSICIST for work on the Printing Qualities of Paper—The Director of Research, Printing and Allied Trades Research Association, 101 Princes Gardens, Acton, London, W.3.

TWO ORGANIZING SECRETARIES (fluent in two languages, with science degree or scientific background)—The British Council, 3 Hanover Street, London, W.1 (marked 'Science Department').

LABORATORY ASSISTANT (male or female) (B.Sc. with a knowledge of bacteriology and chemistry preferred)—The Pathologist, Cumberland Infirmary, Carlisle.

SCIENTIFIC ASSISTANT for the East African Agricultural Research Station at Amani, Tanganyika Territory—The Ministry of Labour and National Service, Appointments Department, Sardinia Street, Kingsway, London, W.C.2 (quoting Order No. O.S.19).

LECTURER IN MECHANICAL OR ELECTRICAL ENGINEERING, and a SCIENCE LECTURER—CHEMISTRY and/or PHYSICS with subsidiary Mathematics, at the Swansea Technical College—The Director of Education, Education Department, Guildhall, Swansea.

GRADUATE MISTRESS (MATHEMATICS) for Barrett Street Technical School, Oxford Street, London, W.1, and Maidenhead—Application Form T.1/40 from the Education Officer (T.1), County Hall, Westminster Bridge, London, S.E.1.

PSYCHIATRIST (part-time) and an EDUCATIONAL PSYCHOLOGIST (part-time) at Child Guidance Clinics to be established by the Kent Education Committee—The School Medical Officer, Public Health Department, County Hall, Maidstone, Kent.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Memoirs of the Cotton Research Station, Trinidad. Series A: Genetics. No. 19: Colchicine-Produced Polyploids in *Gossypium*, 1: An Autotetraploid Asiatic Cotton and certain of its Hybrids with Wild Diploid Species. By S. G. Stephens. Pp. 26. (London: Empire Cotton Growing Corporation.) 2*s*. 6*d*.

Nature Conservation and Nature Reserves. Report drawn up by a Committee and approved by the Council of the British Ecological Society, October 1933. Pp. 38. (Cambridge: At the University Press.) 1*s*. 6*d*. net. [61

Lecture on 'Chemistry and Cancer'. By Dr. J. W. Cook. Pp. 36+3 plates. (London: Royal Institute of Chemistry.) [61

The Education and Training of Chemists. Report of the Chemistry Education Advisory Board. Pp. 16. (London: Royal Institute of Chemistry.) [61

Department of Scientific and Industrial Research. Index to the Literature of Food Investigation. Vol. 14, No. 3, December 1942. Compiled by Agnes Elisabeth Glennie, assisted by Catherine Alexander. Pp. iv+151–226. (London: H.M. Stationery Office.) 4*s*. 6*d*. net. [61

UFAW: Universities Federation for Animal Welfare. Seventeenth Annual Report for the Year ending September 30th, 1943. Pp. 4. (London: Universities Federation for Animal Welfare.) [61

Other Countries

U.S. Department of Agriculture. Leaflet No. 236: Preventing Damage to Commercial Dried Fruits by the Raisin Moth. By Heber C. Donohue, Perez Simmons, Dwight F. Barnes, George H. Kaloostian and Charles K. Fisher. Pp. 6. 5 cents. Technical Bulletin No. 841: Life-History and Control of the Tomato Pinworm. By John C. Elmore and A. F. Howland. Pp. 30. 10 cents. (Washington, D.C.: Government Printing Office.) [41

Imperial College of Tropical Agriculture: Low Temperature Research Station. Memoir No. 19: The Respiration of Bananas during Storage at 53° F. and Ripening at Controlled Temperatures. By E. R. Leonard and C. W. Wardlaw. Pp. 379–424. (Trinidad: Imperial College of Tropical Agriculture.) [61

Annals of the New York Academy of Sciences. Vol. 44, Art. 4: High Polymers. By Raymond M. Fuoss, J. Abere, W. O. Baker, Henry Eyring, John D. Ferry, Paul J. Flory, C. S. Fuller, G. Goldfinger, R. A. Harman, Maurice L. Huggins, H. M. Hulbert, H. Mark, H. Naidus, Charles C. Price, John Rehner, Jr., Robert Simha and A. V. Tobolsky. Pp. 263–444. (New York: New York Academy of Sciences.) [121

Catalogue

CoAx Articulated Air-Spaced Cables for High Frequencies. Pp. 6. (Beaconsfield: Transradio, Ltd.)

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.

MINISTRY OF LABOUR AND NATIONAL SERVICE

The following full-time lecturers and instructors are required for the Technical School of a Government Department. This school will give part time courses during normal working hours to Engineering and Trade Apprentices. The courses will lead to National and Higher National Certificate in Mechanical or Production Engineering, City and Guilds, and Associate Fellowship of the Royal Aeronautical Society.

Salaries will be according to the Burnham scale, but extra allowances may be granted to those applicants with special qualifications. Location of work in Surrey.

Engineering Lecturer—Ref. No. C.1997A.
Candidates should have academic qualifications to the standard of a University Degree in Engineering, preferably honours, and practical engineering and teaching experience. They should be capable of lecturing to University degree standard in some of the following subjects:
- Aerodynamics.
- Theory of Machines.
- Strength of Materials.
- Theory of Structures.
- Applied Thermodynamics.

Mathematics Lecturer—Ref. No. A.422A.
Candidates should be capable of lecturing in Mathematics up to Higher National and A.F.R.Ac.S. standard and should have an Honours degree in Mathematics.

Physics Lecturer—Ref. No. A.423A.
Candidates should be capable of lecturing in Heat and Heat Engines, Electricity and Magnetism, and Electro Technics, up to National Certificate standard. They should hold a University degree in Physics or Engineering and should have some practical engineering and teaching experience.

Assistant Mathematics and Physics Lecturer—Ref. No. A.424A.
Candidates should have a University degree in Mathematics or Physics, preferably Honours, and should be capable of lecturing up to Intermediate Degree standard in Mathematics and Physics.

English Lecturer—Ref. No. O/N.390.
Candidates should have a University Degree in Arts, Economics or Pure Science with experience in teaching English and Industrial History.

Drawing Office Instructor—Ref. No. C.1998A.
Candidates should be able to give instruction in Engineering Drawing and Machine Design up to Higher National Certificate standard. They should have extensive practical design, engineering and teaching experience.

Engineering Instructor—Ref. No. O/N.391.
Candidates should be able to give instruction in Engineering Drawing and Machine Design, and should be familiar with shop processes and methods and have had extensive practical engineering, as well as teaching experience.

Demonstrator—Ref. No. O/N.392.
A Demonstrator is required for work in the laboratories, and to assist lecturers in class work generally. Candidates should have sound engineering or general physics training to at least Inter. B.Sc. standard.

Applicants should write to the Ministry of Labour and National Service, Central (Technical and Scientific) Register, Advertising Section, Alexandra House, Kingsway, London, W.C.2, for the necessary forms which should be returned completed on or before February 16, 1944. The reference number for the post applied for must be quoted.

UNIVERSITY COLLEGE, NOTTINGHAM

The Council invites applications for the appointment of ASSISTANT LECTURER IN PHYSICS. Salary £300-£350 according to qualifications and experience. Further information and form of application, which must be returned not later than Saturday, February 12, may be obtained from the Registrar, University College, Nottingham.

THE UNIVERSITY OF LIVERPOOL

PHYSICIST REQUIRED FOR DEPARTMENT OF OCEANOGRAPHY

Applications are invited for the position of Lecturer in the Department of Oceanography. Applicants need not possess any extended knowledge of Physical Oceanography, but should be prepared to take observations at sea, and to consider the prospects of making their career in oceanographical research. They should be prepared to carry out research on the design and construction of instruments for the making of physical measurements at sea.

The appointment will be made at an early date, on the understanding that the man appointed takes up his duties as soon as he becomes available.

The commencing salary will not exceed £400 per year.

Applications should be made to The Registrar, The University, Liverpool, 3.

UNIVERSITY COLLEGE, LEICESTER

DEPARTMENT OF CHEMISTRY

Applications are invited for the post of Assistant Lecturer and Demonstrator in Chemistry. Preference will be given to candidates having special qualifications in physical chemistry. Salary £300 per annum with participation in Universities' Superannuation Scheme. Duties to commence October 1, 1944. Applications should reach the Registrar, from whom further particulars may be obtained, not later than February 21, 1944.

NORTH STAFFORDSHIRE TECHNICAL COLLEGE, STOKE-ON-TRENT

Principal: H. W. Webb, D.Sc., F.I.C., M.I.Chem.E.

HEAD OF MINING DEPARTMENT

Applications are invited for the post of Head of the Mining Department at the above College. Salary scale £600–£25–£800. In fixing the commencing salary, allowance may be made for special qualifications and experience.

Written applications, giving particulars of training, qualifications and experience, should be sent to the undersigned before January 31, 1944.

Education Offices, Town Hall, Hanley — J. F. CARR, B.Sc., Clerk to the Governors.

BRIGHTON TECHNICAL COLLEGE

Applications are invited from Scientists of high academic qualifications with teaching and administrative experience in University or Higher Technical Colleges, for the PRINCIPALSHIP of the above College, which will shortly become vacant on the retirement of W. Mansergh Varley, M.A., D.Sc., Ph.D. Salary £1,000 by £50 to £1,100 per annum, plus current Burnham war bonus. Further particulars and forms of application (which must be returned by February 21) may be obtained from the undersigned on receipt of a stamped addressed envelope.

54 Old Steine, Brighton, 1. — F. HERBERT TOYNE, Education Officer.

CITY OF NORWICH

APPOINTMENT OF BIO-CHEMIST

APPLICATIONS are invited for the above-mentioned post from suitably qualified and experienced persons. The officer appointed will be under the general supervision of the M.O.H.

Salary £500 p.a. (plus appropriate cost of living bonus) rising subject to satisfactory service, to £700 p.a. (plus bonus).

For full particulars and conditions of appointment apply to the Medical Officer of Health, 68 St. Giles' Street, Norwich, by whom applications for the post must be received not later than February 16, 1944.

Books wanted: Debye "Polar Molecules"; Haas "Theoretical Physics," Vol. 1; Stuart "Molekül Struktur"; Ann. Reports Chem. Soc. 1930-1933, 1938-1942.—Box 147, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

UNIVERSITY OF DURHAM

THE MEDICAL SCHOOL, KING'S COLLEGE
DEPARTMENT OF PHYSIOLOGY

Applications are invited for a full-time Lecturer in Physiology. Salary at the rate of £350 to £500 per annum according to qualifications and experience.

The successful candidate will be required to take up the position as early as possible. Further particulars can be obtained from the undersigned to whom four copies of applications, accompanied by the names of two referees, should be sent not later than Wednesday, February 9, 1944.

King's College, Newcastle-upon-Tyne. — G. R. HANSON, Registrar.

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: TEMPORARY DEMONSTRATOR in the DEPARTMENT of ZOOLOGY. Candidates must have an Honours Degree in Zoology. Salary £250-£300 plus war bonus.

Last date for receiving applications, Saturday, February 5, 1944. For further particulars apply the Secretary, Regent's Park, N.W.1.

CUMBERLAND INFIRMARY, CARLISLE

(VOLUNTARY HOSPITAL)

Assistant for Laboratory wanted, male or female. B.Sc. with a knowledge of bacteriology and chemistry preferred. Salary according to experience, commencing at not less than £300 p.a. Federated Superannuation Scheme in operation. Applications together with two recent testimonials should be addressed to the Pathologist, immediately.

DUNDEE TECHNICAL COLLEGE

Applications are invited for the post of Lecturer in Chemistry. Salary £300–£10–£400, plus war bonus, with placing for experience. Candidates should possess an Honours degree in Chemistry or an equivalent qualification. Particulars of duties, and application forms, which should be lodged not later than Saturday, February 5, may be obtained from the Clerk and Treasurer, Dundee Institute of Art and Technology, Bell Street, Dundee.

Chemist with Ph.D. degree or the equivalent experience required for the Research Department of a Heavy Chemical concern in the Manchester area. Applicants should have specialized in organic chemistry, but should also be competent to tackle problems in the inorganic field. The post is a permanent and progressive one. Please reply with full details to Chief Chemist, Box 141, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Research Chemist required for develop-ment work, mainly in connection with thermoplastic materials, Essential Works, North London; New Laboratories. Salary £500 per annum, permanent position; previous experience of synthetic resins desirable, but not essential.—Full particulars to Box 146, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

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 7968.)

Wanted: Reviews of Modern Physics, Vol. 6, 1934. Review of Scientific Instruments, February, 1943.—Box 148, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

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.

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