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THE SPIRITUAL VALUE OF RESEARCH

SCIENTIFIC workers are adding here and there to human knowledge, and from time to time it is opportune to take stock in science, to ask whether the efforts are directed towards the best ends or whether we are largely chasing our own tails in working on details of established problems.

For the purpose of this inquiry a distinction may be drawn between pure and applied scientific research, though admittedly it is improper to do so. In the first place, it is legitimate to wonder whether the best brains seek scientific work as a career. Differences in the work and in the environment of the work demand different traits of temperament and character. The level of intelligence which the honours training ensures does not necessarily mean the possession of great inventive capacity or powers of imagination. There is rather a tendency to sneer at the man engaged in utilitarian science ; one sees such expressions as the greed for gain, the prostitution of science, blatant insistence on profit making. Such accusations are frankly not true ; the scientific worker in industry, even if he has never published a paper in a scientific journal, can be and often is at least the equal of the academic worker.

The point is best illustrated by reference to the United States, where there are as many and as competent men of science at work in the universities and colleges as in Great Britain. In addition, most Americans will agree that there are as fine or an even finer set of brains engaged in perfecting the new discoveries and finding practical uses for them of benefit to man. Very often the practical use of something new has to be forced on man : he is told by means of advertisement that here is something that he really wants, whereupon he begins to buy it, but before long something of real value results from the development : this is happening more and more often. The chemists, for example, sought long to find a use for butyl alcohol : in the end, spray paints were discovered ; not only are they of the greatest value to the motor-car industry, but also they have revolutionized the paint industry. There is nothing ignoble in making something useful, while in regard to profit, large or small, unless an article can be sold at a profit the inventor can neither live, make experiments, nor even induce anyone to undertake manufacture. President Roosevelt, speaking of a report of the National Research Council to Congress, has said it "presents a clear record of how successfully we have translated our old time Yankee ingenuity for invention into American genius for research".

Some of the facts relating to the United States are striking. Thus in 1940, 2,200 industrial corporations maintained 3,500 research laboratories

employing 70,000 workers at a cost of seventy-five million pounds. In these, particular emphasis is directed towards personal qualities of the prospective employee as distinguished from scholarship. Creative urge, receptiveness to new ideas and intellectual integrity are particularly important. It is such men and their gifted leaders who have made the wholly synthetic textile 'Nylon', at a staggering experimental cost which it will take a long time to recover from profits. Nylon bids fair to make the world independent of Japanese silk. In addition, all sorts of new uses, perhaps of equally outstanding value, will be found for the fibre.

Nothing which is said here indicates any desire to check pure research; it is realized that great discoveries come only seldom and then perhaps after years of patient groundwork, also that "the wind of genius bloweth where it listeth". A difficult problem such as that of cancer must be attacked from many sides; a tiny advance here may lead to definite progress elsewhere.

There is, however, much to be gained by planning a research. In industry it is of value occasionally to review a research problem on its completion, so as to see how much time could have been saved if none but useful experiments had been undertaken: often the necessary time is but a small fraction of the time actually spent. Research expenditure is usually roughly proportional to sales: it becomes difficult to know how much money to allocate to subjects which are far in advance of the specific problems of an industry. But to-day American 'big business' men firmly believe in research and believe that they would suffer seriously were it discontinued. Chairmen produce slogans when they talk to shareholders: "The fountain of youth for a corporation is technical research which has been properly organised for profit." "Every discovery has a tremendous background. . . . Every discovery in turn is a link in the chain leading to further development." "The products of to-day's researches are a base for to-morrow's orders." "The price of progress is research which alone assures the security of dividends."

Speaking of the glass industry in the United States, in which the over-riding control is exercised by one or two organizations, Prof. W. E. S. Turner has said that "so far from resting on the position acquired, they appear to be intent on strengthening the position by research development work on a considerable scale".

It must not be forgotten that many research problems are so costly nowadays that only the largest organizations can finance them. A technical research is no longer a problem for a single man with two or three helpers; it may involve a team of a hundred scientific workers and necessitate the building of a small experimental factory.

Research expenditure in such industries as food, textiles, leather, forest products has lagged behind that in the oil, rubber, chemical and electrical industries; there is, however, just as much room for it and as much reward awaiting success. Research need, indeed, should not be confined to process inventions but extended by co-operation between management and labour to fatigue, industrial psychology and related matters. To employ each worker in a way that best suits his capabilities, to enable him to perform a full day's work with a minimum of fatigue, are all desiderata which should make the strongest appeal to any well-managed firm.

Although what has been said above had direct reference to science in industry, it also applies fundamentally in so-called pure science. As Sir Henry Dale pointed out in his presidential address to the Royal Society (p. 678), the work of the Medical Research Council and its sister bodies is evidence of the value of research under careful control exercised on behalf of the Government.

If it be accepted that no man is happy unless he works, and that the work should be worthy of the effort, then the need to ensure that each of us is enabled to do his best in congenial work is beyond question. The worker has the obligation to become fully trained, to be patient until the opportunity arises to step into his ideal post and to render service such as will justify his salary, the oncost on his job and provide something for the future development of his industry. It may take years to find out whether one has chosen a career wisely; there may be steps to be retraced, adjustments to be made, but so long as there is a spiritual desire to make good, success, however it may be defined, can only be round the corner.

There is constant complaint about the apathy of the public towards science, its ignorance of science; but perhaps the fault is as much on the side of men of science as that of the public. In general, men of science fail to tell the public what is going on; why, for example, margarine to-day is the equivalent in most respects of butter, whereas twenty years ago it was much inferior; the public cannot find this out for itself.

Men of science surely have a duty to the public to learn to write more simply, so as to bring home to a far larger audience than is reached at present what science means and what it is doing. Until this can be done, no complaint of the neglect of science is justified. We may have smashed the atom and realized the alchemists' dream by the manipulation of the bits, but it does not make sense when we let the lay newspapers hint that gold from lead has become a practical possibility.

AGRARIAN PROBLEMS OF MEDIEVAL EUROPE

The Cambridge Economic History of Europe from the Decline of the Roman Empire
Edited by Prof. J. H. Clapham and the late Prof. Eileen Power. Vol. 1 : The Agrarian Life of the Middle Ages. Pp. xvii+650. (Cambridge : At the University Press, 1941.) 30*s*. net.

THE history of which this is the first instalment is not only a co-operative, but also an international work. The fifteen contributors to the present volume represent schools of history or economics in France, Belgium, Germany, Switzerland, Austria, Poland, Russia, Finland, Sweden, Jugoslavia, Great Britain, and the United States. The result is a series of essays in which the agrarian development of most European countries is traced by specialists, familiar alike with the original materials and the scattered literature which has arisen around them. The task of assembling these articles under war conditions must have been very difficult, and all English students of economic history should be grateful to the editors whose resolution has made it possible. The gratitude of those who use the volume will be deepened by the knowledge that Prof. Eileen Power, who planned it and prepared much of it for the press, died with tragic suddenness while the work was still in the printers' hands.

No general synthesis of results is attempted in this volume. The attempt would in any event have been unprofitable, for research in the field as a whole has not yet reached a point at which large-scale conclusions can safely be drawn. It is still possible for specialists to differ abruptly from one another on the fundamental question of the extent to which the economic life of the Roman Empire survived the barbarian invasions of the fifth and sixth centuries. What can be undertaken is a survey of tendencies, and in two articles this limited aim is brilliantly achieved. Without any evasion of controversial issues, Marc Block traces the evolution of seignorial institutions in an essay which is not only learned, but also singularly clear, and at all salient points, convincing. The introductory essay on the settlement and colonization of Europe, by R. Koebner, is a masterly description of the first discernible stages in the economic development of western Europe, and of the historical and physical factors which by their interplay determined its course. The article is of especial interest through the judicious use which it makes of the English evidence, which previous workers have often under-estimated.

The articles on individual countries form a set of regional surveys which will be very useful as an abstract of existing knowledge. The essays which deal with the remoter European States fill a gap of which English students have long been aware. For a considerable time to come, readers who wish to know about agrarian conditions in medieval Spain, Poland, the Scandinavian countries, Russia, or the Byzantine Empire will be well advised to turn in the first place to the essays, and then to the bibliographies, printed here. The fact that many of these essays are hard to read is partly due to the difficulty of explaining technical details in a narrow space, but still more to the uncertainty which overhangs much of the detail itself. For most of the countries of northern and eastern Europe, the material available for economic study is unevenly distributed both in space and time. Outside England and the regions covered by the Carolingian Empire, there is remarkably little evidence which bears directly on the origins or the early stages of economic evolution. In Denmark, for example, the oldest documentary authorities are of the late eleventh century, and the terminology of medieval records is so elliptical that scholars differ widely about its meaning at essential points. As important changes in the methods of land distribution are known to have occurred in medieval Denmark, it is not surprising that few definite facts can be given about the primitive Danish economy.

On the general question of agrarian origins, it is interesting to see that scholars in all countries are tending to use the evidence of place-names as a clue to the character of early forms of agricultural association. The evidence has been unduly neglected in the past. But the interpretation of place names, even when their original forms have been ascertained, is beset with difficulties, and there are articles in this volume in which the results of place-name study are used with more assurance than would be felt by those who have worked on these problems from the linguistic side.

All this means that medieval economic history, as yet, falls far short of scientific precision. The patterns of agrarian life, painfully reconstructed by the modern student, were evolved, even more painfully, by generations of peasants preoccupied with the task of wringing subsistence year by year from land which, on any flagging of effort, would revert to wilderness. The expedients which they adopted in the attempt to escape from the compulsion of their environment varied within each country from place to place. The economic historian, in recording the result of their efforts,

is describing the average of a vast number of experiments. The writer comes nearest the truth who realizes most clearly the number and range of the variations from this mean. Every contributor to this history brings out the diversity of the conditions with which he is dealing. But the limited space at the disposal of each writer has meant that significant variations of the agrarian system are sometimes understressed. It would scarcely be gathered from the essay which deals with England how many exceptions there are to the types of agricultural economy which historians tend to regard as characteristic of different parts of the country.

On this point, it may be suggested that the reader would have been helped by a slight addition to the content of the volume. The importance of money as a solvent of agrarian custom is recognized on all hands. But the treatment of currency problems is reserved for a later portion of this "History". The result is that the present book contains no general discussion of the conditions under which a 'money economy' came into being in different European countries. The need for a survey of these conditions is one among many reasons for hoping that the second volume of this valuable "History" will not be long delayed.

F. M. STENTON.

THE CONTINENTAL SHELF

Atlantic Submarine Valleys of the United States and the Congo Submarine Valley

By A. C. Veatch and P. A. Smith. (Geological Society of America, Special Paper No. 7.) Pp. xvi+101+10 plates. (New York: Geological Society of America, 1939.) £1 10*s*. net.

The Origin of Submarine Canyons: a Critical Review of Hypotheses

By Prof. Douglas Johnson. (Columbia Geomorphic Studies, No. 3.) Pp. ix+126+4 plates. (New York: Columbia University Press; London: Oxford University Press, 1939.) 15*s*. 6*d*. net.

DURING the past fifteen years, the methods by which hydrographic surveys are made have fundamentally changed, and both the accuracy attainable and the speed of working have greatly increased. These changes are due partly to the introduction of the echo sounder and partly to new methods of position finding when out of sight of land. The paper by Veatch and Smith, with its accompanying charts, represents one of the first products of these technical advances, and gives us, for the first time, a survey of an extensive area out of sight of land in which the positions of the soundings can be relied on sufficiently for steep bottom forms to be contoured. The area treated is off the eastern coast of the United States from Cape Henry to Georges Bank. The charts are on a scale of 1 : 120,000 and show all the thousands of soundings on which the contours are based.

As is well known, the surface of the continental shelf on the Atlantic seaboard of the United States is a relatively featureless plain sloping very gently seaward. Beyond the 100 fm. line, however, the gradient suddenly steepens to about one in forty, and large irregularities appear in the topography. It is in this area, between the 100 and 1,000 fm. lines, that the main interest of the work lies. Unfortunately, the spacing of the lines of soundings, although they are many times more numerous than in previous surveys, is too wide for the contours to be traced in a purely mechanical way. The authors have therefore assumed that the bottom forms are similar to those due to stream erosion on land, and have drawn a set of contours satisfying the observed soundings and depicting an erosion surface. The assumption considerably restricts the form of the contours, for it requires the gradient of a valley bottom never to change sign and all valleys to branch upwards. The authors explain very clearly what they have done and say that they have made numerous attempts to fit other types of topography without success. To establish whether or not the irregularities shown by these soundings do represent a stream-like pattern is among the most important problems of geology, and is one that could in happier times be easily solved by a detailed examination of a small area. From a somewhat superficial examination of the charts it appears that, while not every irregularity shown by the contours is certainly present in Nature, yet it is established that the topography consists of ridges and valleys running up and down the slope.

Whatever may be the form of the minor relief on the slope, the present charts leave no doubt as to the form and position of those major features that have been called submarine canyons. Nine major canyons occur in the area covered by the charts. The largest is the Hudson canyon, which is about fifty miles long, six miles wide and has a maximum depth of 3,700 ft. below its rim. These canyons are cut as nicks into the edge of the shelf and do not extend more than a few miles inside the 100 fm. line. They are not connected in any striking way with the present rivers on land.

Veatch and Smith, having convinced themselves of the existence of a stream-like pattern, believe that this pattern has actually been cut by streams. They boldly lower the sea 12,000 ft. some 25,000 years ago and return it to its present level so recently as 3000 B.C.

Although we have only recently acquired a detailed knowledge of the form of the canyons, their existence has been known for many years, and a great body of comment and speculation has accumulated concerning their origin. The main object of Prof. Johnson's monograph is to review critically this obscure and scattered literature. The canyons must either have been formed under the sea or out of it. If the latter, then either the land must have been raised or the sea lowered. The changes required are so large, so widespread and so recent as to reduce the argument almost to an absurdity.

If the canyons were formed under the sea, then either they were eroded by some kind of submarine current or else they were undermined by submarine springs. The hypothesis that mud-laden currents were responsible for excavating the canyons has been strongly urged by eminent authorities, but is rejected as inadequate by Prof. Johnson. He believes that undermining by submarine springs is the primary agent in excavating the canyons, and supports this view with arguments from a wide variety of natural phenomena. Quite apart from the correctness or otherwise of the views expressed, the whole book compels the reader's admiration by the extent and variety of the sources from which he has drawn his information.

Actually, this view of the genesis of submarine canyons has much to commend it. It requires no catastrophes, it does not need any straining of the laws of physics, or any very exceptional circumstances. The principal doubt is whether the structure of the shelf is such that artesian conditions are possible on the slope. At first sight this would require the slope to be a fault or erosion feature, which would be an unwelcome assumption to many. More careful consideration suggests that this may be avoided, and the more attractive idea of a lens or delta-like accumulation of sediments retained. Among other possibilities the author suggests that the water for the springs might be that expelled from the sediments during compaction.

However these doubtful matters may finally be decided, it is clear that the present data are only a beginning of a vast undertaking, and that the unravelling of even the outlines of submarine geology will occupy many years. Further improvements in technique will be necessary to extend the work to deep water. This will require the solution of many difficult and interesting problems in physics, seamanship, and geology, and will require the close co-operation of experts in these matters.

E. C. BULLARD.

CONCEPTS OF ELECTRICITY

Introduction to Electricity and Optics

By Prof. Nathaniel H. Frank. Pp. xii+398. (New York and London: McGraw-Hill Book Co., Inc., 1940.) 24*s*. 6*d*.

THIS book has been written as a text-book for second-year students at the Massachusetts Institute of Technology. "The goal to which it aspires is a compact logical exposition of the fundamental laws of the electric and magnetic fields and the elementary applications of these laws to circuits, to a study of the electrical and magnetic properties of matter, and to the field of optics." A slight acquaintance with the calculus and a knowledge of elementary physics is assumed on the part of the student.

There are no descriptions of apparatus or experiments or historical accounts of the development of the subject, and the physical principles have not been used simply as pegs on which to hang mathematical problems. An account of the principles on which the theory is based, of their meaning and the way they are related to one another, is aimed at. In fact the author is trying to teach physical instinct directly by an unhurried and in some respects very skilful presentation of 'key' facts and calculations, and not by letting the student acquire it unconsciously by drill in calculation and experiment. Elementary alternating current circuits, Maxwell's equations of the electromagnetic field, the theory of dispersion and Planck's radiation law are done in an elementary manner, but there is no reference to, for example, the ballistic galvanometer. There is no obsolete or obsolescent matter in the book, but it is not too modern; the quantum is barely mentioned. In some respects the treatment is very unusual, as for example in magnetism, where the magnetic pole is relegated to a subordinate position. There are collections of good problems, but the solution of some will require help from outside the book.

The book is to be regarded, therefore, not as a conventional text, but in conjunction with the

author's companion book on mechanics and heat as a text-book on physics from an unusual point of view. It would probably be very helpful to second-year physics classes at universities where the physics is ahead of the mathematics, and generally where physics is being combined with chemistry and not with mathematics. It is undoubtedly a book for the college library. Teachers will enjoy the freshness of outlook, but may disapprove of the selection of matter. The book is well produced, but the price is high.

R. A. HOUSTOUN.

BEHAVIOUR OF IODINE IN THE BODY

The Endocrine Function of Iodine

By Prof. William Thomas Salter. (Harvard University Monographs in Medicine and Public Health, No. 1.) Pp. xviii+351. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1941.) 3.50 dollars.

ANY work dealing with the behaviour of iodine in the body is bound to be mainly an account of the physiology of the thyroid gland. It is chiefly for this that biochemist and clinician alike will consult the book under review. Neither will be disappointed; for the author shows himself to be equally at home in the laboratory and in the ward.

It is evident from the title, however, that the author considers that iodine is concerned also in the workings of the other endocrine glands. It must be admitted that the evidence for any direct connexion is a little thin; but in so far as the endocrine glands are mutually dependent, they may all be said to participate in a manner in iodine metabolism. Their mutual relationships are well discussed; and in expounding the view that all the endocrines are dependent on and controlled by each other (rather than all directed by the pituitary) Dr. Salter is able to coin a new and topical phrase—"the pituitary-thyroid axis"—which, with its variants, may in time replace Cushing's older orchestral simile.

Interesting as these speculations are, they have at present no direct clinical application; the instrument which the clinician most hopes the biochemist will provide him with is an unequivocal method of determining the amount of circulating thyroid hormone in the blood. Given this instrument, many of his problems would automatically be solved, and many questions settled which he can now only speculate about. The introduction of methods of estimating iodine in small quantities of blood has brought that goal within sight; but before it can be attained, an improved technique of separating the active from the inactive iodine is required.

The form in which the thyroid hormone circulates n the blood is not at present known, but it may be presumed to be a protein, containing thyroxine among its amino acids. Therefore, so far as the hormone is concerned, only that fraction of the plasma iodine which is bound to protein is of interest. Iodine is bound, however, to the proteins of the plasma with varying degrees of intensity; how much this linkage is a matter of chemical combination, and how much of adsorption, is far from clear. The greater part of the protein-bound iodine can be extracted with alcohol or acetone, the amount extracted depending largely on the thoroughness of the extraction. The amount so extracted by various arbitrary procedures of this type has been termed by many investigators 'organic iodine', and taken to represent the hormone itself. This premature assumption is largely responsible for the confusing results reported in the literature.

Although recognizing the many possible fallacies, the author has given close consideration to all the reported values for blood iodine in health and disease. In spite of the technical weaknesses, all investigators have found that the level of the part of the iodine which is most closely related to protein corresponds roughly to the expected level of thyroid hormone. Thus plasma organic iodine is low in myxœdema and high in thyrotoxicosis, and in the latter disease it tends to return to normal after appropriate treatment of the patient.

Dr. Salter has himself confirmed these general conclusions. His method is to estimate simply the iodine which is precipitated with the plasma-proteins. (He suggests, for future use, a further subdivision—after alkaline hydrolysis—into thyroxine-like and di-iodotyrosine-like fractions.) The exceptions and difficulties are frankly dealt with, and the author makes it clear that the protein-bound iodine cannot be taken to be identical with the thyroid hormone. He describes, for example, a marked rise in protein-bound iodine on administering potassium iodide to cases of myxœdema. Nevertheless he regards the test as already of some practical use in diagnosis; although the ten cases described to illustrate this point may leave the clinician wondering whether these particular problems could not have been solved by less elaborate methods.

The recent work on the administration of iodine 'labelled' with radioactive isotopes is fully described. The most useful isotopes appear to be those of mass 128 (with a half-life of 25 minutes) and of mass 131 (with a half-life of 8 days). The work so far done on this promising subject has accomplished little more than the verification and amplification of conclusions reached by the older methods; the astonishing rate of uptake of iodine by the thyroid (particularly when hyperplastic) is illustrated by the finding that, after intravenous injection of a radioactive iodine, the peak of its concentration in the gland is attained within 10–15 minutes. The author touches on the therapeutic possibilities of radioactive iodine, by which theoretically a brief bombardment of tremendous intensity could be delivered from within the thyroid itself by what should be attainable doses. A short section describes the biological effects of the newly discovered element No. 85, which seems to have in common with iodine an affinity for the thyroid.

Other topics dealt with in this book include the artificial iodo-proteins, iodine balance and the relation of the nervous system to iodine metabolism; while an appendix gives details of the methods employed by the author to estimate and fractionate iodine in biological material. The discussion of the varied problems concerning the behaviour of iodine in the body is conducted throughout with the easy competence of one who is familiar with every by-way of his subject. The new series from the Harvard University Press could have no better introduction than this scholarly work.

W. R. TROTTER.

A NATURALIST IN THE HIGHLANDS

Highland Gamekeeper

By Dugald Macintyre. Pp. 246+8 plates. (London: Seeley, Service and Co., Ltd., n.d.) 12*s*. 6*d*. net.

IT is a relief in times of war and stress to turn for relaxation to books written of Nature, lofty and serene. "Highland Gamekeeper" brings to the mind happier days, for it is written by one whose whole life has been spent out of doors, studying wild birds and wild animals. The author comes of old Highland stock; his great-grandfather, Allan Macintyre, was Kintyre's last bard and foxhunter, and we are told that the immortal Gaelic poet, Donnchadh Bàn nan Oran, Duncan Ban Macintyre (who, as is known, was a natural poet of the hills and no scholar), came to the author's ancestor Allan to have his poems written out.

With this ancestry there is little wonder that the author from his early years should have found himself a keen observer of Nature. We follow him through early to mature years, when he volunteered for active service in France in the War of 1914–18—he gives a vivid picture of shooting game over a recent battle-field and seeing a snipe which he had put up driven back to him by a peregrine falcon—down to the present day when from his home in Perthshire his observant eye notes the poaching kingfishers of the Earn and the strong-flying blackcock in the high-lying glens of the strath.

There are some valuable observations in the book. Who, for example, has seen a pair of wild peregrines bathing? On p. 59 Mr. Macintyre gives a vivid picture of this, for the peregrine to him is almost as familiar as the sparrow to less fortunate folk. A crime of the great black-backed gull is brought home to us (p. 102) in a manner which loses nothing through its simple terseness. But the author's outstanding achievement was his discovery (p. 107 *et seq.*) that curlews periodically eject the epithelial lining of the gizzard. He describes how he was able to convince the sceptics that this remarkable event did indeed take place. He writes:

"The discovery was made after I had examined numbers of curious little pouches which I saw lying in the pools of a marsh. Thousands of curlew used that marsh as a roosting-place, and I at first supposed that the queer objects were partly digested turnip leaves. The finding of a newly-shed pouch containing coarse white quartz grit led to my sudden recognition of the fact that the pouches were really the cast linings of curlew gizzards."

It was perhaps natural that the authorities at first were disinclined to accept his discovery, but:

"I forwarded about fifty shed gizzards to the FIELD office, together with several newly shot curlew for dissection, and the fresh gizzard-linings of other curlew, shot and dissected by myself. In the FIELD of the following week two authorities to whom the question was referred, Mr. R. H. Burne, of the Royal College of Surgeons, and Dr. H. Hammond Smith, pathologist to the FIELD, accepted my discovery as a new and true one, and Mr. J. E. Harting, the Naturalist Editor, quoted

the following excerpt on gizzard-renewal from Professor Newton's 'Dictionary of Birds' : 'As a rule the cuticle (gizzard lining) is continually wearing away and being reproduced, but many cases are known in which most of the lining is suddenly cast off and ejected through the mouth'."

The author adds :

"I often heard curlew having long spells of coughing by night, but only understood what that meant after my discovery. The function of stomach-renewal takes place in early autumn, and it is in September or early October that one finds newly-shed pouches."

Mr. Dugald Macintyre is a keen fisherman, and has found that an effective lure for seatrout in the lower pools of a river at dusk is small saithe flies. I myself have caught saithe when fishing for seatrout in the tidal waters, and have known of one occasion when a silvery herring snatched the fly and was landed.

The author narrates (p. 136) an occasion on which a cold spell which visited Mull suddenly during October 1936 had the effect of causing stoats to turn white prematurely, and believes that the weather largely influences their change of colour.

SETON GORDON.

CAUSATION OF MENTAL ABNORMALITY

The Psychodynamics of Abnormal Behavior

By Prof. J. F. Brown, with the collaboration of Dr. Karl A. Menninger. (McGraw-Hill Publications in Psychology.) Pp. xvi+484. (New York and London : McGraw-Hill Book Co., Inc., 1940.) 24*s*. 6*d*.

THERE are a number of faults which are common to introductory books on psychopathology. They are often written by those who have themselves but a smattering of the subject—in spite of the fact that it needs wide acquaintance with it to write easily in simple language. Such books usually deal with fundamental material, which the student could read with advantage in the original work, and so neglects the more recent advances. Finally there is often a gross bias in favour of one particular school of thought.

These faults have been avoided by the authors of the interesting book under review. It is an excellent introduction to psychopathology planned for the student, but the general physician will also find it of interest.

The writers take the organismic point of view as their basis and, although they have a strong psychoanalytic leaning, they are critical in everything they say and do not repeat simplified orthodoxy. For example, they state : "We need more precise definitions of our theoretical concepts. In our criticism of psychoanalytic theory we saw that, despite the very great genius of Freud and many of his followers, many of the concepts were ambiguous and not at the present time capable of either scientific definition or experimental evaluation. It is to be hoped that the collaboration of psychoanalysts and academically trained psychologists will bring about a sounder background for psychopathology." This broad-minded view is taken throughout the book. Everywhere the importance of psychosomatic factors is noted ; for example, on p. 68 it is stated : "A discussion of the several types of mental abnormality indicates the presence of psychic factors in those usually thought of as purely somatic and of organic factors in those usually thought of as purely psychogenic."

The book is divided into five parts. Part 1 deals with the organismic point of view (the reaction of the individual in his environment), normality, abnormality, the nature of personality, the historical development of psychopathology and the psychosomatic problem. Part 2 describes symptomology, modern ideas regarding symptoms, abnormalities of the cognitive, motor and emotional processes. Part 3 deals with the theory of the genesis and structure of the personality. Part 4 gives an outline of psychiatry (including sexual abnormalities and genius). Part 5 suggests the future possibilities of the psychodynamic theory. It is this last part which is of most interest to the practising psychiatrist, since it is full of common sense and points to many fascinating developments.

The book is well presented, with excellent binding and good print. The style is clear and illustrated with diagrams. It should be easy for one who has had a little acquaintance with psychology to understand the theories presented, but naturally those who are studying medicine should augment it with a text-book of psychiatry, since the clinical descriptions are a little curtailed. The value of the book is enhanced by a full bibliography—there are eighteen pages containing some four hundred references, mainly of recent work. There are also good author and subject indexes which make the book a pleasure to use.

CLIFFORD ALLEN.

Assam Adventure

By F. Kingdon Ward. Pp. 304+16 plates. (London: Jonathan Cape, Ltd., 1941.) 12*s*. 6*d*. net.

THIS is the kind of book that makes any flower-lover's mouth water. Kingdon Ward had, of course, to make the chance for himself. But what a chance it was! Wandering about in a flower paradise with nothing else to do but collect the most glorious plants. Thirty-nine rhododendrons—that alone should be enough to satisfy most plant lovers; but in addition such treasures as the Tibetan blue poppy, known all over the world as *Meconopsis baileyi* but now more accurately described as the *Meconopsis betonicifolia baileyi*; then ten different species of primulas and seven gentians. All these Kingdon Ward has through three journeys into south-western Tibet been able to introduce into cultivation in the West. It is a great contribution to the happiness of mankind and some little set-off to the present horrors of war.

We could have wished that Kingdon Ward had that other plant-collector, Reginald Farrer's, gift of description. But Farrer was a literary genius at describing flowers such as comes only once in two or three generations; and if he could not find the exact word to describe the colour or form of a flower he would deliberately coin a word for it. Kingdon Ward lacks that gift. But he has to some extent made up for it by the beautiful photographs with which his book is illustrated and which give us a fine impression of the kind of country in which the flowers are found. This is another important part of Kingdon Ward's work: he describes in detail the physical conditions of temperature or moisture, of shade or sunshine under which the many plants he has introduced to cultivators are found in their own native habitat.

F. Y.

Historic Thorn Trees in the British Isles

By Dr. Vaughan Cornish. Pp. 94+9 plates. (London: Country Life, Ltd., n.d.) 8*s*. 6*d*.

DR. VAUGHAN CORNISH in his interesting study of historic thorn trees shows that their distribution in England coincides strikingly with the areas invaded in the south by the Belgic tribes from Gaul, and in northern England, by the Parisii, an adjoining tribe. From these tribes probably originated the cult of the thorn as a sacred tree—a cult still persisting in some remote districts in England, and common in Ireland, where the fairy trees are protected with superstitious reverence. The legend of the Glastonbury thorn gathered Christian associations around the thorn.

These cherished trees planted in later times as marks for assemblies of 'hundreds' or parishes, or as forest boundaries, and in some instances—as in that of the author's own inheritance, the Salcombe Regis Thorn—maintained by replanting to the present day, trace back in their story the history of their locality. Rectors of country parishes and anyone with an interest in the past and present of their district will find Dr. Vaughan Cornish's account of the thorn trees fascinating.

The English May tree speaks of our past. May Day celebrations gather round it to-day. The fresh emphasis the War has given to the value of English trees should make this history of one of the most characteristic, timely.

The Nature of the Chemical Bond and the Structure of Molecules and Crystals

An Introduction to Modern Structural Chemistry. By Prof. Linus Pauling. (The George Fisher Baker Non-resident Lectureship in Chemistry at Cornell University.) Second edition. Pp. xvi+450. (Ithaca, N.Y.: Cornell University Press; London: Oxford University Press, 1940.) 28*s*. net.

THIS book is lineal successor in a series of famous books dealing with structural chemistry from a physical point of view, the first of the line being G. N. Lewis's "Valence and the Structure of Atoms and Molecules". The first edition of Prof. Pauling's work was published two years ago. Its well-merited popularity led to the exhaustion of the first edition, and a second has now been prepared. This preserves practically the whole of the text of the original edition, but is improved and brought up to date by the inclusion of a further 20 pages, devoted mainly to the discussion of structures which have been studied by quantitative methods since the earlier edition was prepared for press. To a subsidiary extent the new matter consists of various expansions of the theoretical argument of the original work. The molecules of which the structures are discussed for the first time include the $Mo(CN)_8''''$ ion, which has the remarkable form of a triangle-faced dodecahedron, and *cis*-azobenzene; the new crystal structures include silicon disulphide and molybdenite.

Science in Peace and War

By Prof. J. B. S. Haldane. Pp. 229. (London: The Scientific Book Club, 1941.) 2*s*. 6*d*.

THE suspension of the *Daily Worker* has deprived the public of Prof. J. B. S. Haldane's weekly articles on scientific developments. The Scientific Book Club has, however, come forward and issued a new edition of his second set of collected articles. His new readers will find much entertaining material, for no one equals Prof. Haldane at casual human comment on the facts of science.

In connexion with the *Thetis* disaster, Prof. Haldane gives some very interesting details about his father's researches, which commenced with analyses of the air in the slums of Dundee in 1885 and 1886. Sometimes as many as eight persons occupied one bed in a single room, while in other cases there was no bed at all. His investigations convinced him that the high death-rate in overcrowded houses was not due to chemical causes, but to bacteria. He experimented on himself, and on his son. From the age of ten, Prof. Haldane used to accompany his father on research expeditions in mines. He tells us that his father always said that the most interesting physiological problems are those which arise in ordinary life.

J. G. CROWTHER.

INTERNATIONAL COLLABORATION AND FREEDOM OF SCIENCE*

By SIR HENRY DALE, C.B.E., F.R.S.

AS we come to the end of another year we can see, as yet, no prospect for science of escape from the urgent preoccupation with the means of waging war. On the contrary, with the Union of Soviet Russia now locked in a supreme struggle for its own existence and the world's freedom, and with the United States of America rapidly directing its tremendous scientific and technical potential to the support of the same great cause, the diversion of science from its normal uses and objectives has spread right round the world. Yet even this grim necessity has brought with it some measure of compensation, in drawing closer the bonds of friendship between the men of science in the countries thus united in a common purpose. We in Great Britain received a tremendous encouragement, in the early months of this year, from the visit of President J. B. Conant and his associates to establish in London an office for the maintenance of regular and intimate co-operation between the war researches of our American colleagues and those which are here in hand. More recently, and in spite of all difficulties of communication, the sense of a common peril and a common determination is bringing us into a new and growing intimacy of collaboration with our colleagues of Soviet Russia. The organization of the science of the British Empire for war has brought to London already a number of distinguished colleagues from the Overseas Dominions, and we have heard of others who are on the way. It has been a particular pleasure to gather them here, in the house of the Royal Society, and to invite them to regard it as a centre and a rallying point for discussion of the means by which this new and closer collaboration, arising under the stimulus and the necessity of war, may be perpetuated and strengthened for the purposes of peace.

Generous gifts to the Society, during the year, from sister societies in America, have given further welcome evidence of the determination of our colleagues there to come to the help of British science in this time of need. The American Philosophical Society, founded in 1743 by Benjamin Franklin, with the Royal Society as his model, sent us ten thousand dollars "for the aid of science in Britain". They have confirmed our interpretation of their fraternal gift as betokening a desire to help us to preserve some measure of normal scientific activity in Great Britain during the War, and to keep alive the tradition of a free pursuit of knowledge for the benefit of all men. We have been able to find good use already for a large part of this benefaction, in the maintenance of a number of important researches, which war conditions had threatened to interrupt or to bring to an end. The American Physiological Society similarly sent the Royal Society five thousand dollars as a spontaneous contribution to the support of scientific publication in Great Britain, mentioning physiology as the subject to which they, as physiologists, desired us to give the first consideration. The Rockefeller Foundation, that truly international benefactor and promoter of natural knowledge, had already asked the Royal Society to be responsible for the distribution of twelve thousand five hundred dollars in aid of scientific publication in Great Britain in these difficult times.

Gifts such as these, welcome for their own intrinsic value and for the practical uses which we are readily finding for them, are even more welcome on account of the evidence that they bring of the feeling of comradeship between our American colleagues and ourselves. We can do no less, I think, than assure them of our determination that this closer sense of unity in aims and ideals, with them as with our fellow-citizens of the British Overseas Dominions, shall not be lost, but rather strengthened, when we face together the new problems which the end of the War will bring.

Though the first and imperative call on the science of all free countries is for the means of winning the war, to save the freedom without which science cannot in any true sense survive, we cannot put aside the duty of preparing for the part which science must play in rebuilding and maintaining civilization when peace returns. The Conference recently organized by the British Association on "Science and World Order" attracted more attention from the Press and the public than is usually given to scientific events and discussions; and it was, indeed, an impressive and significant fact that men of science from a dozen or more different countries, some far distant, should have found it possible now to meet, here in our war-scarred London, and to find the time and the impulse for such debate. We may offer our very sincere congratulations on the success of such an enterprise.

Many who took part in these meetings, held at a time when science finds itself conscript and organized as never before for the destructive pur-

* From the presidential address to the Royal Society, delivered on December 1.

poses of war, were clearly ready to support the view that it should be as fully organized by the Governments of a world at peace, for its proper purposes of enriching life and enlarging the opportunities of happiness for all men alike. There were not wanting voices, however, such as that of our Biological Secretary, to sound a warning of dangers which might be entailed by such fullness of association between science and government as others were advocating with conviction and enthusiasm. Freedom and opportunity, it was pointed out, rather than organization, provide the conditions for the highest types of research, and thus, in the end, for the greatest services which science can give to mankind. I find myself in sympathy with this view, and nobody here, I think, would suggest that it is usually possible to organize the researches which advance boldly into the unknown, and open new vistas to human understanding. Here we shall certainly not overlook the fact that, in the period between the two wars, important funds have been placed at the disposal of the Royal Society by a series of generous benefactors, to be administered for the support of researches over a wide range of subjects, in complete independence of any control by the State.

On the other hand, I think that it will be agreed that the remarkable development in Great Britain, since 1914, of the State support of research administered by the three Advisory Councils—the Department of Scientific and Industrial Research, the Medical Research Council and the Agricultural Research Council—normally in relation to the needs and the activities of a nation at peace, has taken place without any obvious detriment or danger to the freedom of science. The Royal Society's former function, of advising the Government directly on all scientific matters, and of organizing such systematic researches as were then undertaken in the public interest, has, of necessity, been shared and greatly diminished. We, as a Society, however, can fairly regard this development as, in many respects, a realization of the plans and the dreams of our predecessors here; and I do not think it fanciful to claim that our Society's traditions and standards have been still effective, through the influence of our fellows on the Advisory Councils and their Committees, and through the filling of their chief executive offices by men of our fellowship. As a whole-time research worker myself, since 1914, under the body which became the Medical Research Council, and the senior now in that service, I can bear grateful witness to the freedom of opportunity which can exist under an enlightened organization and control, exercised on behalf of the Government. I have no reason to suppose that the conditions are otherwise under the other Research Councils. Nor should we lose sight of the fact that a further large proportion of the free research of the country is now indebted to support from the State through grants to the universities, administered without any trace of detailed Government control.

While, therefore, the existing mechanisms for the support of science by the State are doubtless susceptible of improvement at one point or another, I find no reason to fear any threat to the freedom of science from them, or from any natural development on those lines. Nor do I fear it from a wider use of the organized application of science and scientific method to problems of public welfare; nor, again, from a more effective access of scientific knowledge to those responsible for government. A year ago Sir William Bragg told the Royal Society of the formation of the Scientific Advisory Committee to the War Cabinet, under the chairmanship of Lord Hankey, with the President and two Secretaries of the Royal Society as members *ex officio*. The representation of the Society has, indeed, been strengthened since then, and in a manner most welcome, by the fact that, though I have succeeded him *ex officio*, Sir William Bragg still gives his wisdom and experience to the work of that Committee, as an extra member.

There is one direction, however, in which I do find some reason to fear for the freedom of science. If science should become entangled in controversial politics, through the over-eagerness of its advocates and champions to invoke the sanction of science, or to claim its potentialities, in support of any special political doctrine, then indeed I believe that the threat to its freedom might become a real danger. Let there be no misunderstanding of my meaning. I am not abusing the privilege of this chair by using 'controversial' as an epithet to be applied to political opinions which I do not happen to share. I see danger if the name of science, or the very cause of its freedom, should become involved as a battle cry in a campaign on behalf of any political system, whether its opponents would describe it as revolutionary or reactionary. If science were allowed thus to be used as a weapon of political pressure, it would be impossible to protect science itself eventually from the pressure of sectional politics. If that should happen the dangers are, I believe, beyond dispute—the danger, for example, that fundamental researches, having no immediately practical appeal, would be allowed to fall into arrears through relative neglect; or the danger that the rigid standards of true science would be relaxed, by allowing the convenience of results for policy or for propaganda to enter into the assessment of their validity as evidence.

The Royal Society, with its firm and unbroken tradition of complete aloofness from political controversy, may still find it an important part of its function to keep watch and, if necessary, to stand without compromise for the right and the duty of science to seek the truth for its own sake, in complete freedom from any kind of extraneous influence. I hope, indeed, that there will never be need thus to invoke our tradition, in order to protect the freedom and the integrity of science from the enthusiasm and the advocacy of any of its friends.

PHYSICAL CONCEPTS OF THE MESON THEORY OF THE ATOMIC NUCLEUS

By Prof. W. Heitler
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A SYMPOSIUM was recently held at the Dublin Institute for Advanced Studies, at which the present state of the meson theory was discussed. The present article discusses some of the views expressed, so far as they may be of interest for the general reader. Most of the views put forward in this article—if not generally known—have been discussed in recent years between Dr. H. Fröhlich and myself.

There is at the present time a veritable jungle of literature on the meson theory of the nucleus. Quite apart from the sometimes very extensive calculations, there exist at present two or three different meson theories—they differ essentially in the value attributed to the spin of the meson—and each is claimed to have great advantages. This in itself may be sufficient to stress the very preliminary character of the theory. The meson theory is entirely based upon the principles of quantum mechanics and of special relativity. Yet it could scarcely be expected that these principles will be sufficient to solve the problem of the elementary particles; something going far beyond relativistic quantum mechanics will be needed for this purpose. Nevertheless, the meson theory has already yielded a number of very valuable results and suggestions which can be considered as safe whatever the future development may be. We may perhaps compare the situation with that obtained by applying Lorentz's classical theory of the electron to an atom, treating the latter as a classical oscillator. The most striking feature, the existence of stationary states, cannot be understood in this way, but a number of other features, such as the absorption and scattering of light, can be understood quite well. Thus we must not expect that the present meson theory can be used to calculate exactly the binding energy of the deuteron, or that it can give any other quantitative results; but we can expect to obtain a large number of qualitative results and order of magnitude relations between the fundamental properties of the elementary particles. These properties turn out to be largely independent of the particular form we choose for the theory and can be explained by using general arguments only. (This does not mean that the development of the formalism is superfluous. It has indeed its merits—and very important ones—but a discussion of this lies outside the scope of the present article.)

The meson theory originated from an ingenious idea put forward by Yukawa in 1935. In order to describe the short-range forces prevailing between a proton and neutron, Yukawa introduced a new kind of field, φ, which was thought to be analogous to, but different in nature from, the electromagnetic field. The short range of these forces requires a modification of the field equations so that the static part of the field is now described by a modified 'Poisson' equation:

$$\nabla^2\varphi + \lambda^2\varphi = 0 \qquad (1)$$

with its singular solution, $\varphi = g\, e^{-\lambda r}/r$. The range of the forces is approximately $1/\lambda$. It is an *experimental* fact that $1/\lambda$ is of the same order of magnitude as the classical electron radius e^2/mc^2. g is a new universal constant with the dimensions of a charge. It determines the strength of the nuclear field. We derive its value below.

From (1) we can go over to a wave equation describing waves *in vacuo*:

$$\nabla^2\varphi - \frac{1}{c^2}\ddot{\varphi} + \lambda^2\varphi = 0. \qquad (2)$$

(2) can also be considered as a relativistic wave equation for a particle, but in contrast to the corresponding equation in Maxwell's theory, it describes the free motion of a particle with a *finite rest mass*, $\mu = \hbar/c\lambda$. Using the fact that $1/\lambda \doteq e^2/mc^2$ (m is electron mass), we obtain for the new mass the order of magnitude:

$$\frac{\mu}{m} \doteq \frac{\hbar c}{e^2} = 137 \qquad (3)$$

Moreover, it has long been concluded from the

saturation of the nuclear forces and other facts that the forces between a proton and neutron are connected with an *exchange of electric charge*. If this is taken literally, it must mean that the electric charge is not necessarily concentrated at the position of the proton but can also be found between the two particles. In other words, the nuclear field φ must itself carry electric charge. The free particles described by (2) are consequently *charged particles*, positive and negative, as will be seen below.

Three years after Yukawa had published these ideas, particles with these properties were discovered in cosmic radiation and named 'mesons'. The actual mass was found to be about $180m$, in good agreement with (3). Secondly, the cosmic ray mesons are charged (positive and negative). The agreement of these two facts with the prediction from purely nuclear considerations is so striking that there can be no doubt about the basic correctness of Yukawa's ideas.

Next we have to determine the value of the new universal constant g. For this purpose we use two more experimental facts: (i) The size a of the deuteron is little greater than the range of the forces $1/\lambda$. This is by no means trivial. The size of a hydrogen atom is the Bohr radius, whereas the range of the Coulomb forces is infinite. (ii) It is known that in the ground state of the deuteron the kinetic energy is almost equal to the potential energy, leaving only a small fraction of the potential energy for the binding energy. According to the uncertainty relation, the kinetic energy is

$$E_{kin.} \doteqdot \frac{\triangle p^2}{M} \doteqdot \frac{\hbar^2}{a^2 M} \doteqdot \frac{\hbar^2 \lambda^2}{M}.$$

The potential energy is approximately $E_{\text{pot.}} \doteqdot g^2\lambda$. Thus we find $g^2 \doteqdot \hbar^2\lambda/M$, or

$$\frac{\hbar c}{g^2} \doteqdot \frac{M}{\mu} \doteqdot 10. \qquad (4)$$

This gives a value for g of about 4 elementary charges e. The similarity of (4) and (3) is very striking. The two dimensionless universal constants $e^2/\hbar c$ and $g^2/\hbar c$ are both equal to the ratio of the masses of two elementary particles. Both relations are deduced from experimental facts, and so far we have no deeper insight into the meaning of these relations.

We have looked upon the field φ from two different aspects. On one hand, we have considered it as a field of force, and on the other hand, as a Schrödinger wave function for the meson as a particle. The two aspects are entirely equivalent. While the Maxwell field is primarily a field of force and can only be looked upon as a wave function for light quanta in special cases, and on the other hand the Schrödinger wave function of an electron never acts as a field of force, we can consider the meson field φ from whichever point of view is more convenient. Indeed, the production of the static field $ge^{-\lambda r}/r$ by a proton or neutron is often described in the particle picture as a "virtual emission and reabsorption" of a meson. This picture can often be used with advantage.

What is the precise meaning of this expression? We have already seen that the field φ carries an electric charge. If we would carry out an experiment to find the charge at a distance r, say, from the proton (or neutron), we shall, indeed, with a certain probability, find a charged particle at that point. (The charge can, of course, only appear in the form of a particle, that is, in an integral multiple of e.) The word emission in the above expression has thus a very literary meaning. On the other hand, such an emission of a particle with a rest mass μ would be contrary to the law of conservation of energy. While all other conservation laws (charge, momentum, angular momentum, spin, statistical) are fulfilled during this emission, the word 'virtual' means that, in contrast to a real emission, energy need not be conserved. If we therefore carry out an experiment to find the charge at a distance r from the proton, this experiment will only give a positive result if the necessary energy μc^2 is *supplied by the measuring process itself*.

This argument can be used to derive the extension of the nuclear field in a direct way without referring to a particular wave equation. The argument is due to Wick, but we give it here in a somewhat modified form. We measure the position of the meson at a distance r with an accuracy $\triangle r$ of the order of magnitude of r itself. The particle will then have an average momentum $\triangle p = \hbar/r$. This is connected with an uncertainty of the energy

$$\triangle E \doteqdot \frac{\triangle p^2}{\mu} \text{ (if } \triangle p \text{ is not much larger than } \mu c).$$

$\triangle E$ is also the energy supplied by the measuring process. In order that the actual finding of the particle is not contradictory to the conservation of energy, $\triangle E$ must at least be equal to μc^2. Thus the experiment can only be successful if $\hbar^2/\mu r^2 \geq \mu c^2$ or

$$r \leq \hbar/\mu c. \qquad (5)$$

This expression gives the extension of the region in which the meson can be found, in other words, the extension of the nuclear field; and is identical with Yukawa's relation.

The next question is: How big is now the probability α of finding the meson outside at a distance r from the proton? Here the limitations of the theory become apparent. α depends, of course, on r, but it is clear that r must not be chosen too small. First of all, no meaning can be attached

to a dissociation where the meson is practically at the position of the proton, since this state is indistinguishable from the undissociated state. If r is smaller than $\hbar/Mc$, the measuring process supplies energies larger than Mc^2, and pairs of heavy particles can be created. The picture of a dissociated proton then fails completely. Even if we choose $r=\hbar/\mu c$, the concept of emission of a single meson fails, since then pairs of mesons can be created. To be on the safe side, we have therefore to restrict our concept to distances not much smaller than $1/\lambda$. But these are just the distances where the physical effects are of interest. Although for many problems the theory can actually be applied to much smaller distances, the simple concepts developed in this article break down in the very region in which they are of most interest. We cannot expect any quantitative results from them, but in the region of $\hbar/\mu c$ the results will be of qualitative significance.

To find the probability of dissociation, we calculate the total energy contained in the field outside $1/\lambda$ and divide it by the energy of the meson. It is safe to conclude from the analogy with the Maxwell field that the energy density is of the order of magnitude of $\mathrm{grad}^2\varphi \doteq g^2\lambda^2$ at the distance $1/\lambda$. The volume of the region where the energy density has this value is of the order of magnitude of $1/\lambda^3$; thus the total energy is g^2/λ. The energy of the meson is $\sim\mu c^2$. The fraction of time spent in the dissociated state is therefore

$$\alpha = \frac{g^2}{\lambda\mu c^2} = \frac{g^2}{\hbar c} = \frac{1}{10}. \qquad (6)$$

The nuclear particles have so far been considered as point- or mono-poles, being the sources for the field around them. Accordingly, the field was spherically symmetrical. There is, however, evidence that these are not the only sources of the meson field. It is known that the proton neutron force depends essentially upon the relative spin directions of these two particles. The difference between the singlet and triplet potentials of the deuteron is of the same order of magnitude as the potential itself. It must therefore be concluded that the spin of a heavy particle acts also as a source for a meson field, the latter being no longer spherically symmetrical but having a signified direction in the direction of the spin. The dependence on angle of this field is that of a wave function of a particle in a p-state. Thus we attribute to the spin of a proton or neutron a 'mesonic dipole' $\sigma f/\lambda$ (σ is the spin of the heavy particle), where f is another constant with the dimensions of a charge. At the distances of interest ($1/\lambda$), this field has the same order of magnitude as the field of the mono-pole if the two constants g and f are of the same order of magnitude. This assumption can account for the spin dependence of the nuclear forces.

If we look upon the dipole field from the particle aspect, we can describe it in the following way: The proton is also capable of emitting virtually a meson with *angular momentum of one unit*, the angular momentum having the same direction as the spin of the proton before the dissociation. In order to satisfy the conservation of angular momentum, the spin direction of the heavy particle in the dissociated state must be the opposite one. The fraction of time spent in this kind of dissociation is also of the order of magnitude $\alpha = f^2/\hbar c \doteq g^2/\hbar c$.

Considerations of this kind lead to the qualitative explanation of another very important feature, namely, the anomalous magnetic moments of the proton and neutron. It is clear that a meson with angular momentum 1 has a magnetic moment larger by a factor M/μ than 1 Bohr nuclear magneton. This contributes to the magnetic moment of the proton an amount $\alpha\, M/\mu$ (in units of the nuclear magneton) which explains why the magnetic moments have such odd values. During the dissociation, the heavy particle is a neutron and has therefore no magnetic moment of its own. The heavy particle itself contributes therefore a magnetic moment $1-\alpha$. The total magnetic moment of the proton is therefore

$$m_P = 1-\alpha+\alpha M/\mu. \qquad (7)$$

Similarly, the magnetic moment of the neutron will be

$$m_N = -\alpha-\alpha M/\mu, \qquad (8)$$

where regard has been taken of the fact that the neutron emits a negative meson with the opposite sign of magnetic moment, and that in the dissociated state the neutron has become a proton with opposite spin direction. (In (7) and (8) no account has been taken of the fact that a proton can dissociate into states where the meson has no angular momentum. It can easily be seen that this does not alter the result appreciably.)

Since both m_P and m_N are of the order of magnitude unity, we see that α must be of the order of magnitude of μ/M. But this is just the relation (4) derived from the binding energy and size of the deuteron, and gives further support for the assumption that this relation is not accidental. If we insert in (7) and (8) the observed values of $m_P=2{\cdot}78$ and $m_N=-1{\cdot}93$, we have two equations for a new independent determination of α and M/μ. We find

$$\alpha=0{\cdot}075 \qquad \text{and} \qquad M/\mu=20,$$

in reasonable agreement with the values previously obtained for these universal constants.

The consistency of these results suggests that the

fundamental concepts of this theory are correct. We must not forget, however, that we have restricted our considerations to distances of the order of magnitude $1/\lambda$. Little can be said at present about the contributions of smaller distances. All we can say is that their contributions to the effects considered are at most of the same order of magnitude as those from greater distances. Our results are largely independent of the particular formalism chosen to describe the meson field, so long as it conforms with what we had to postulate. Many important details, however, do depend on the value chosen for the spin of the meson (0 or 1, or both); for example, the order of the levels in the deuteron, and the behaviour of the meson during collisions with other particles and light quanta. In some cases more or less serious difficulties arise if the theory is applied to distances smaller than $1/\lambda$. In this respect no definite decision has been reached yet, and we must expect further information from future developments.

Finally, we must also mention the β-decay of the meson. This was originally a second idea of Yukawa's, quite independent of his theory of the nucleus. It was assumed that the meson can decay directly into an electron and a neutrino. The decay of the meson has since been confirmed experimentally. The great advantage of this hypothesis is that it reduces the β-decay to a much simpler form. Whereas a nucleus decays emitting the electron into a continuous range of energy, the electron emitted by a free meson can only have the energy $\mu c^2/2$ (leaving the other half for the neutrino). The β-decay of a nucleus then takes place by means of an intermediate emission of a meson but the fundamental process underlying the β-decay of a nucleus is the decay of the meson. It is clear that a detailed study of the meson decay will give us very valuable information about the most important problem of the existence of the neutrino. A detailed discussion, however, lies outside the scope of this article.

BIOLOGICAL ACTION OF VITAMINS

By Dr. Elizabeth M. Koch

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SOME of the outstanding developments in vitamin research reported in the symposium on the "Biological Action of Vitamins", held at the University of Chicago as part of its fiftieth anniversary celebration during September 15–17, were:

(1) The further clarification of the functions of diphosphothiamin in carbohydrate metabolism by Mr. Severo Achoa, of Washington University, in St. Louis; (2) The separation of a new B vitamin, folic acid, a yeast growth stimulant announced by Mr. Roger J. Williams, of the University of Texas; (3) The proof of the identity of biotin, vitamin H, and co-enzyme R, presented by Mr. Vincent du Vigneaud of Cornell Medical College, New York City; (4) The isolation from egg white of avidin, a substance which combines with and thus inactivates biotin, also reported by Mr. Roger J. Williams; (5) The description of a new choline deficiency effect in young rats characterized by hæmorrhagic degeneration of the kidneys, described by Mr. Wendell H. Griffith, of St. Louis University, in St. Louis; (6) The description of the symptoms of human ariboflavinosis by Dr. W. H. Sebrell, of the United States Public Health Service; (7) The extension of vitamin therapy in human nutritional diseases, reported by Dr. Norman Joliffe, of New York University, by Dr. David L. Smith, of Duke University, and by Dr. Tom Spies, of the University of Cincinnati; (8) The use of vitamin K to prevent bleeding in patients having a low prothrombin content in the blood, reported by Drs. Harry P. Smith and Emory D. Warner, of the University of Iowa.

Mr. Achoa, in his discussion of the functions of diphosphothiamin, pointed out that through its effect on the oxidation of pyruvic acid, diphosphothiamin may be expected to influence various phases of carbohydrate metabolism. This is true because of the fact that pyruvate oxidation causes the storage of a considerable amount of energy in the form of adenosine triphosphate. We may expect diphosphothiamin to be indirectly involved in the synthesis of glycogen from glucose and in the conversion of fructose to glucose, since these reactions are driven by the mobilization of the phosphate bond energy in adenosine triphosphate.

Mr. Achoa also suggested the possibility that diphosphothiamin may aid in the absorption of sugar from the intestines and in resorbing glucose in the kidney tubules. It also may be involved in the process of forming carbohydrate molecules from lactic acid or from pyruvic acid. This vitamin complex likewise hastens production by the body of acetylcholine, an agent involved in the neuromuscular mechanism.

Folic acid, so named because it is most abundant

in leaves, was discovered as an important factor in yeast nutrition. Its isolation was accomplished this year by Mr. Roger J. Williams and his co-workers, who report its presence in all animal tissues examined, as well as in leaves. The implication that it is involved in animal nutrition is obvious, although nothing is known as yet of its function in the higher organisms.

Mr. Williams also discussed the various bio-assay methods, using yeasts and bacteria which have been developed by his group for the quantitative estimation of the eight water-soluble B vitamins discovered to date: thiamin, riboflavin, nicotinic acid, pyridoxin, pantothenic acid, biotin, inositol and folic acid. These methods have proved highly satisfactory with respect to ease of manipulation and reproducibility of results.

Mr. Vincent du Vigneaud described the story of the steps by which three lines of research on vitamin H, the anti-egg-white injury factor, on biotin, one of the factors essential for yeast growth, and on co-enzyme R, which functions in the growth and respiration of many strains of legume nodule organisms—the Rhizobia—have converged to show that the three activities reside in one single substance.

In 1936 Kögl and Tönnis announced crystalline biotin. In 1939, West and Wilson suggested that biotin and co-enzyme R are probably identical. In 1940, György, Rose, Hofmann, Melville and du Vigneaud noted the similarity of the properties of vitamin H with those of co-enzyme R and biotin. They found that their vitamin H concentrates had parallel activity for the other two factors. A biotin methyl ester preparation contributed by Kögl had high vitamin H unitage. The du Vigneaud group then prepared biotin methyl ester from a vitamin H liver concentrate, and using this preparation confirmed the identity of biotin, co-enzyme R and vitamin H. Their product had a melting-point of 166°–167°, which is 18° higher than that reported by Kögl for his preparation. No explanation for this difference in melting-point has been found.

The structural formula of biotin has not been completely solved. It is probably a cyclic urea derivative with the composition $C_{10}H_{16}O_3N_2S$. By the action of barium hydroxide at 140° it forms a diaminocarboxylic acid, $C_9H_{18}O_2N_2S$. Biotin has been resynthesized from this diaminocarboxylic acid by treatment with phosgene.

Of interest in its relation to biotin was the reported isolation by Mr. R. J. Williams and his group of avidin from egg white. This is the substance which combines with and inactivates biotin, thus producing the so-called egg-white injury which develops when raw egg white is fed to rats and chicks.

The effect of choline deficiency on young rats was described by Mr. W. H. Griffith. Young rats on a low choline, low fat and low cholesterol diet exhibit an extremely toxic effect in which there is a marked hæmorrhagic enlargement and degeneration of the kidneys, a regression of the thymus and an enlargement of the spleen. The degeneration of the kidney particularly is very rapid, and may cause death in a ten-day period. The deficiency is prevented by amounts of choline too small to influence the deposition of liver fat. Supplements of cystine, fat or cholesterol increase the severity of the lesions; choline, menthionine and betaine neutralize their toxic effects. Since cystine, fat and cholesterol also increase the amount of fat in the livers of older rats, it appears that the hæmorrhagic degeneration and fatty livers are different manifestations of the same deficiency. The work of du Vigneaud and his co-workers proving that choline is involved in transfer of methyl groups indicates that the symptoms described are evidences of methyl deficiency. Griffith and his associates found that a creatine supplement lessens the severity of the lesions, but does not entirely prevent them. He suggested that while the methyl group of creatine is not available for choline synthesis, it may exercise a sparing action by making available for choline synthesis the methyl groups which would otherwise be used in the formation in the body of creatine.

As each vitamin has been made available in crystalline form, clinicians have studied its effect in the treatment of human subjects who present symptoms similar to those shown by animals that have been maintained on diets deficient in that specific vitamin. Dr. Joliffe discussed the use of thiamin for many types of polyneuritis frequently associated with alcoholism, pregnancy, gastro-intestinal disturbances and pellagra, as well as for cardiovascular disturbances, œdema, anorexia, and many other symptoms which may be manifestations of a sub-acute deficiency. He emphasized the importance of finding a means to detect early and mild vitamin deficiencies.

The history of pellagra and the final discovery that nicotinic acid is a specific for its cure long after this vitamin had been isolated, found ineffective in curing beriberi, and discarded as of no nutritional value, was related by Dr. David T. Smith. He described in detail the symptoms of nicotinic acid deficiency and the methods of treatment.

One of the most striking clinical developments in the vitamin field during the past two years has been the recognition of riboflavin deficiency symptoms. These were described by Dr. Sebrell. Dr. Sebrell and his co-workers placed eighteen adult women on a riboflavin-deficient diet. The first symptom

ROYAL AIR FORCE EDUCATIONAL SERVICE

Vacancies exist for men graduates with substantial qualifications in Mathematics or Geography. Candidates must be laymen over 32 and not over 55 years of age on September 1, 1941.

Salary

(*a*) The initial salary for teachers in the service of local Education Authorities seconded to these appointments by permission of their Authority, will be at the rate laid down for Secondary Teachers under the provincial Burnham Scale; bearing the number of increments adopted by the Authority in each individual case.

(*b*) In other cases a fixed salary between £284 and £384 per annum according to previous experience.

Both the above subject to a fixed allowance of £70 payable in addition to salary.

The Teachers (Superannuation) Act, 1925, applies to all appointments.

Candidates appointed will be given commissions in the R.A.F.V.R., and will wear uniform. They will, however, be on civilian conditions of service.

Men over 35, already engaged in full-time teaching, or men below that age whose calling-up under the National Service (Armed Forces) Acts has been deferred, should *not* apply.

Those on the Central Register should apply to Central Register (Section G), 41 Tothill Street, London, S.W.1. Those whose names are *not* on the Central Register should apply on a *post-card* for application forms to Under Secretary of State, Air Ministry (E.S.1), Dept Q.J., London.

Applications from persons serving in the Armed Forces or *Government Departments* must be forwarded through the normal official channels.

UNIVERSITY OF BIRMINGHAM

LECTURESHIP IN APPLIED MATHEMATICS

A Temporary Lecturer in Applied Mathematics is required in January 1942; qualifications in mathematical physics will be an advantage. The person selected may be considered for a permanent appointment which will fall vacant at a later date.

The salary offered is £400-£500 per annum according to qualifications; but the Selection Committee is authorized to recommend a higher salary should a candidate of exceptional distinction present himself.

Applications (8 copies), with testimonials if desired, should be sent as soon as possible and not later than December 20 to the undersigned, from whom further information may be obtained.

C. G. BURTON,
Secretary.

The University,
Edmund Street,
Birmingham, 3.
November 1941.

THE WEST OF SCOTLAND AGRICULTURAL COLLEGE

The Governors invite applications for the post of Assistant to the Advisory Officer in Plant Husbandry. Candidates must have an Honours Degree in Pure Science, with a sound training and experience in plant pathology. A knowledge of plant helminthology would be a recommendation.

Salary on the scale £200-£10-£250.

Applications on the prescribed form must be lodged with the undersigned by the 18th proximo.

A. J. WILSON,
Secretary.

6 Blythswood Square,
Glasgow.
November 26, 1941.

THE WEST OF SCOTLAND AGRICULTURAL COLLEGE

The Governors invite applications for the post of Assistant in the Agricultural Economics Department.

Candidates must have a Degree in Agriculture with a qualification in Agricultural Economics, or a similar qualification in Economics with a knowledge of Agriculture. Experience in accounting and field work necessary. The salary will be on the scale £200-£10-£300.

Applications on the prescribed form must be lodged with the subscriber on or before 18th proximo.

A. J. WILSON,
Secretary.

Blythswood Square,
Glasgow.
November 20, 1941.

UNIVERSITY COLLEGE OF WALES, ABERYSTWYTH

The Council proposes to fill the Chair of Agriculture, which will become vacant at the end of the current session, when the present Professor reaches the retiring age.

The salary attached to the Chair is £850 per annum and the person appointed will be expected to take up duties on October 1, 1942.

Further particulars may be obtained from the Principal, to whom applications, with three testimonials and three references, should be submitted not later than January 15, 1942.

PETERBOROUGH & DISTRICT MEMORIAL HOSPITAL

Technician required for Hospital Pathological Laboratory. Apply for further particulars, Secretary-Superintendent, Midland Road, Peterborough.

Research Chemist required in connection with electric lamp development for one of the largest companies. Applicants should give full particulars, including age, training, experience and salary required. They should also state all special experience applicable to electric lamp problems. Box 809, T. G. Scott & Son, Ltd., Three Gables, London Road, Merstham, Surrey.

A research Chemist required by firm manufacturing fungicides and insecticides. Biological training and at least three years' experience with plant protectives essential. Salary according to qualifications and experience. Write, stating age, education, experience, salary required and when free to commence, to Box 810, T. G. Scott & Son, Ltd., Three Gables, London Road, Merstham, Surrey.

Assistant required in Research and Development Department of Aeronautical Instrument Manufacturers. Hampshire area. Good qualifications in physics or engineering desirable, with some research and industrial experience. State experience and salary required. Box 812, T. G. Scott & Son, Ltd., Three Gables, London Road, Merstham, Surrey.

R.A.S. radio mechanic would appreciate copies of Nature after use, paying postage. Box 811, T. G. Scott & Son, Ltd., Three Gables, London Road, Merstham, Surrey.

Microscopes, second-hand, a large selection of instruments in perfect condition; 3d. stamp for list.—Chards, Specialists (Est. 70 years), Forest Hill, S.E.23.

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observed was a pallor of the mucosa in the angles of the lip. A few days later superficial fissures developed exactly in the angle of the mouth. These lesions were covered with a honey-coloured crust which could be scraped off without causing bleeding. The lips became abnormally red and shiny, and the tongue a purplish red. In addition, a fine scaly desquamation appeared about the nose and ears. The ocular lesions were equally marked. The cornea appeared inflamed, due to its invasion by capillaries. This condition was followed by corneal opacity. Patients complained of itching and burning of the eyes, a hyper-sensitivity to light, and eye fatigue.

These symptoms comprise the clinical picture known as ariboflavinosis. Dr. Sebrell has found it very prevalent among people who are not economically restricted to a poor diet. In fact, he stated, without the inclusion of liberal amounts of milk, liver and eggs, it is difficult to select a diet adequate in riboflavin.

In the case of human subjects, clinical experience has demonstrated that vitamin deficiencies are usually mixed, rather than simple, and that the administration of all the vitamins together produces more rapid and complete cures than does treatment with any single vitamin. This phase of vitamin therapy was emphasized by Dr. Tom Spies. He reported a study of "twenty-five malnourished patients with mild pellagra, beriberi or riboflavin deficiency who were becoming worse in spite of bed rest and were refusing the diet offered them. They were given a mixture of brewers' yeast powder (25 per cent), peanut butter (67 per cent) and peanut oil (8 per cent). All except two patients ate it twice a day, and all of them improved gradually." Because such a mixture is a rich source of the natural vitamins of the B complex, as well as of protein, fat, carbohydrate and mineral salts, he suggested the popularization of a sandwich of whole wheat or high vitamin bread, combined with this peanut butter – dried yeast spread as a most effective preventive or therapeutic measure.

The efficacy of vitamin K in preventing bleeding in patients with a low prothrombin concentration in the blood was reported by Drs. Harry Smith and Emory D. Warner. Hæmorrhages due to failure of the blood to clot occur in both mother and child at child-birth, in obstructive jaundice, in chronic intestinal disorders and in bile duct tumours. This failure to clot is due to the inability of the body to produce enough prothrombin. Vitamin K is an essential factor in the production of prothrombin. It is effective administered orally.

Drs. Smith and Warner recommended the inclusion of green vegetables, especially spinach, kale and tomatoes, in the diets of mothers during the last month of pregnancy, and the feeding of cow's milk to infants during the first three days of life to provide the necessary vitamin K during this critical period.

The most recently separated vitamins, pyridoxin and pantothenic acid, are already being studied clinically. Although a pyridoxin deficiency has not been described as a definite entity, the vitamin is believed to function in muscle metabolism. It was reported to cause improvement in patients having muscular weakness or suffering from Parkinson's disease. Here, again, administration with or after thiamin and nicotinic acid produces better results than when pyridoxin is given alone.

Pantothenic acid has been found in human blood. Dr. Edgar S. Gordon, of the University of Wisconsin, stated that very little is known as yet of its possible functions or of its clinical value. Spies and his co-workers found that the injection of pantothenic acid was followed by a rise in the riboflavin content of the blood. He believes that this vitamin is also essential in human nutrition, and that it is associated in its action with riboflavin.

LABOUR CONDITIONS IN WEST AFRICA

By F. W. H. Migeod

FOR countless centuries Africa had supplied labour to Eastern countries. When the American continent was discovered, an immediate demand arose for African labour for its plantations and industries. Eventually the slave trade came to an end, and Africa turned to developing the export of its own products, chiefly forestal. Progress after the change-over was slow at first. At the opening of the present century, however, mining was already well established, and plantations were started to extend the growth of economic products and secure a higher standard of quality. There ensued an increasing demand for paid labour. Nevertheless, in West Africa, the collection and preparation of forest products was still carried on by the natives in their own villages, as it still is. They traded their loads at the nearest store, or the one that offered best terms, and what they received for it was shared out between the members of the family concerned.

Labour in tropical Africa implies rather a different thing from what is understood by 'labour' in Great Britain at the present day. The native tribal organization has usually consisted of a ruling class with the rest of the population slaves, or at least dependants. Merging with the ruling class was general; and another stratum of slave population might be added below as the result of a successful war. Agriculture, the principal industry, was therefore based on slavery. On slave labour the tribe supported itself, and had a small balance of material or, in default, human goods to export. Some tribes kept no slaves; they were cannibals. Some remote hill tribes or swamp tribes may also be exceptions.

When, therefore, the European colonies or protectorates became established, the Government readily obtained the labour it required by calling on the chiefs to furnish so many men for some definite work such as building stations, making roads, railway construction, etc. The labourers would be paid if the work were beyond the chief's confines; within his own country he was responsible for it, and a money gift would usually be made to him in compensation. The Government was only concerned with the labour supplied being kept up to the number specified. Welfare conditions scarcely entered in. The labour largely looked after itself. As a result, however, of the opening up of the country to private enterprise, apart from trading, new conditions had to be met.

This is the background which it is useful to bear in mind when reading the able and valuable report by Major G. St. J. Orde Browne, labour adviser to the Secretary of State for the Colonies, presented to Parliament in May of this year*. Each of the West African Colonies, Nigeria (with British Cameroons), Gold Coast, Sierra Leone and Gambia is studied separately, and roughly the first quarter of the pamphlet contains a summary of observations and recommendations. Major Orde Browne has had long labour experience in East Africa, and in his five months in West Africa in the dry season of 1939–40 he was able by means of extensive and rapid travel to probe into labour conditions in all these colonies.

The welfare of the labourer was his first consideration. The number of instances in which he could find nothing to recommend is testimony to the generally satisfactory labour position of West Africa. It is mostly in the big Europeanized towns where improvements are called for.

It has already been said that labour questions in Africa, and more particularly in West Africa, cannot be treated in the same way as in Great Britain. The great majority of the natives are attached to the soil. This means that everyone has a home to return to whether he be of free or servile origin. He can come out periodically to work for hire, and when he has earned what he considers enough to go back home with, he departs and resumes his agricultural life. He is free so far as his wage-earning is concerned to take it up or not, just as he pleases. Where this general statement does not apply is in the large towns, where a mixed population has collected which has lost touch with home life, and either cannot, on account of distance, or for some other reason does not desire to, return to the place of their birth. Perhaps it is because he is a seasonal worker that he does not like being interfered with even for his own good, a fact Major Orde Browne refers to more than once. He has come to gain money, and will put up with inconveniences to do so. The local abundance of food is a major factor in the choice of his place of work. Often food weighs more in this choice than the actual wages paid.

This report discusses food problems very fully. The view has grown up in recent years in Great Britain that the African is generally undernourished. He used not to be. If undernourishment does exist at all widely, it is a result of economic development of the country, food-growing being subordinated to the production of sale crops or of mechanized industry. Without going deeper into the matter, it may be observed that large markets, such as are especially common in Nigeria, go a long way towards stimulating the growth and equally important distribution of food.

The migratory type of labour, that is the seasonal workers, have in some cases long distances to travel. Usually, however, they know exactly where they intend or hope to work, and travel in parties, some members of which have been over the ground before. There are, of course, cases in which some of the party fall out by the way, and one rather gets the impression from this report of large numbers of would-be labourers arriving at their journey's end worn out with the march and suffering from exhaustion from want of food. Such cases may occur. In any event, rest camps set up by the Government on the main routes are a great boon to the travellers. The mere walk of a few hundred miles is nothing very serious of itself. One has done it oneself. They are not entirely without ideas of food-provision for the journey; and food will be supplemented with saleable goods. In many cases the women go too.

Housing is a subject the migratory labourer is not too greatly concerned with. So long as he has somewhere to spread his mat, and the householder will look after his few personal belongings, he is satisfied. Except when actually asleep the house

* Labour Conditions in West Africa. Report by Major G. St. J. Orde Browne. (Cmd. 6277.) Pp. 149. (London: H.M. Stationery Office, 1941.) 2s. 6d. net.

is scarcely wanted. He especially does not like a draught, having few clothes on indoors; and so concrete houses with tin roofs do not meet with his approval. The hygienic house is not necessarily the most comfortable. However, judging by this report, living conditions in general are good on all the old-established plantations, and are equally so on the mines. Where overcrowding and bad living conditions do apply is in the towns or in the villages surrounding an industrial area; and it is with this very difficult problem that the Medical and Sanitary Department has to cope. Here, too, police problems are equally acute.

All the difficulties, however, in connexion with the labourers who come and do eventually go home, are small compared with the problems of those who do not go, either from illness or some other cause. Only too many of them unable to do regular work turn to crime. They spend their money as they receive it, and when that has become an acquired habit they will in fact never return home. There are many such. They form the body of floating labour, and it is mainly on their account that such reports as Major Orde Browne's are written.

Skilled labour figures equally largely in this report. Such labour is a product of education in some form or other. That may be either apprenticeship in the workshop, or a course of training in Government technical schools. Both systems have their values, and it is debatable whether the youth who has, say, had his training in railway workshops with a certain amount of rough-and-ready treatment, is not better equipped than one who has led a very different life in a residential college, with amenities that render him less willing to undertake any sort of work. Urbanization is, of course, a necessary preliminary to the raising of a large body of skilled artisans, and those persons necessarily become detribalized and merge into the permanent population of the large towns. The report stresses the need for more and still more technical training; and the future of the colonies would seem to lie in a good supply of all sorts of technicians being turned out.

The early trend of education was the production of clerks. Every bright youth at school wanted, and still wants, to become a clerk and wear good European clothes and not do manual work. So associated is manual labour with inferiority of social status (and not in Africa alone), and indeed with old slavery memories, that no native considered he had improved his position unless he adopted the clerical or teaching or some similar profession.

All efforts of the Government to restrict the output of persons trained as clerks have been very largely neutralized by this ambition. When clerkships are, even in their lower grades, better paid than skilled mechanics in their higher grades, and really large salaries can still further be obtained either in the Government service or in trade or the professions, it is not surprising that the youth of the country desires training for the most lucrative work: and their parents share these views. Girls qualify to be telephone operators, shop assistants, etc., but only to a small extent, as the vast body of African opinion still considers the place of the woman is in the home.

For the welfare of labour, Major Orde Browne makes many valuable suggestions, as would only be expected from a man of his experience and qualifications. There is one qualification, however, which one is not sure that he has. One doubts if Major Orde Browne has ever handled labour personally; whether he has ever had to get his labour together for some enterprise, to work it to the utmost, and yet keep it and maintain his employment at such a level of attractiveness that he is never short; also whether he has personally experienced all those repetitions of exasperation and anxiety that success in keeping his own end up implies. The trend of colonial legislation has been to reduce penalties on delinquent labour and increase them for employers; but Major Orde Browne does point out that the latter have in cases been overdone. Unless there are would-be employers with capital entering a colony, there can be no wage-earning; and because a labourer has innocence on his face it does not follow there is innocence in his heart. Trade unionism has been imposed on the colonies from Great Britain. It applies less to the seasonal worker than to the urbanized population. Since, however, in all towns natives of different tribes normally congregate together, and have a titular chief of their own tribe to watch over their interests, the necessity for trade unionism, if any exist, is limited to detribalized natives. In some pages of this report it seems as if there are two persons speaking. One is Major Orde Browne, the experienced African official; the other is someone else who has adapted himself to trade unionism and British labour ideals.

Of the numerous recommendations made, many are expensive. The report was made on conditions prevailing in the earlier period of the War. With the subsequent cessation or limitation of external trade in West Africa, it may be doubted if any more than a small proportion of the recommendations can be put into force. Indeed the necessity for many of them may have lapsed. The best thing the native can do now would seem to be to revert to his former life on his farm and, growing enough food for his family, await a time when industrial and trading activities can be profitable.

NEWS AND VIEWS

Royal Society Personal Records

THE portion of Sir Henry Dale's presidential address to the Royal Society delivered on December 1 which was of wider appeal is printed on pp. 678–80. Another section of the address, at the moment mainly of domestic interest to the fellows, dealt with a scheme which Sir Henry, with the Council's approval, has just introduced, for compiling a contemporary record of the fellows and their activities. The object is to provide the Royal Society with a complete set of personal records of all the fellows from now onwards, with annual additions to keep them up to date. So far as the more senior of the fellows are concerned, many of them, as Sir Henry pointed out, can look back over a period in which the change and expansion of scientific knowledge have been so rapid and so revolutionary that their memories of those days must be of vital interest for the history of science. The biographies of outstanding men of science provide valuable material in the form of impressions and memories of their previous generation, but such sources are relatively few in number. Sir Henry referred in particular to men like Sir J. J. Thomson and Sir Oliver Lodge, whose activities brought them into contact with many outstanding figures, and mentioned the interest—and indeed the value for posterity—of contemporary accounts which might well have been kept by fellows of the Society of their association and discussions with such outstanding figures as Claude Bernard, Louis Pasteur, Robert Koch, Carl Ludwig and others of the latter half of the nineteenth century. The proposed personal record of fellows of the Royal Society will, in Sir Henry's words, "provide a fair picture of the main currents, at least, of scientific progress in this country", which will be invaluable to the future historian who may be called upon to show the general character of this scientific age.

Martyrdom of Polish Men of Science

ON November 26 a meeting unparalleled in the history of science was held at the Royal Institution, where, in the presence of the Presidents of Poland and Czechoslovakia and General Petit (representing General de Gaulle), representatives of scientific institutions and associations from Great Britain and men of science and letters of many nations met to pay homage to the memory of the Polish professors and lecturers who had died as the result of German barbarism, and to register their protest against this crime on science and culture. Sir David Ross, vice-chancellor of the University of Oxford, who presided over the meeting, stated that the Germans are endeavouring to convert Poland into a vassal country by depriving her of her leaders, and that their brutalities fall mostly on academic life. November, 1941, is the second anniversary of the beginning of their many atrocities against science and learning, when the whole of the professorial and lecturing staff of the Jagellonian University in Cracow, the oldest in eastern Europe, was arrested and imprisoned for no other crime than that of being Poles. He described their tortures and humiliations and concluded by saying that the action of the Germans has had the opposite effect to that desired, and the suffering professors have become a symbol of martyred Poland. Dr. Gilbert Murray said that when war breaks out the first casualty is truth, but never has the lie been organized as it now is in Germany.

Prof. Antoni Jurasz, dean of the Polish Medical School in Edinburgh, spoke with an eloquence and fire which in itself was symbolic of the unconquerable spirit of his country. He described the crushing of academic life in Poland, the suppression of all learning, the pillaging of the Universities of Cracow, Warsaw, Lublin, Lwow and Vilno and the destruction of libraries and manuscripts. He spoke of many of those who have met their death, names as well known in other parts of the world as in their own country: professors of philosophy, anatomy, physiology, mechanics, literature, zoology, engineering, biology, physics, chemistry, and many others. The international character of the present meeting testified that all are united to fight the forces of darkness and that on the graves of these fine men and on the ruins of their work will be built up a new world. Prof. René Cassin, member of the "Université de France", who spoke on behalf of the Free French and also on behalf of all Frenchmen who have been reduced to silence by the invader, expressed his horror of the crimes perpetrated on intellectuals in Poland, mentioning the death of students in France who have protested against the aggressor. M. Juraj Slavik, Minister of the Interior, and Prof. Klecanda spoke on behalf of Czechoslovakia and stressed the close association between Poland and their country. Prof. Stefan Glaser, chairman, replied on behalf of the Association of Polish University Professors and Lecturers in Great Britain.

British Chemists and the U.S.S.R.

THE Chemical Society has recently sent the following message of greeting to the All Soviet Union Chemical Society. "We, the President, Council and Fellows of the Chemical Society, send greetings to you, our Colleagues in the All Soviet Union Chemical Society. We express our unbounded admiration for your Country's courage and heroic fight against the power and might of the common foe, and our deep sympathy in the suffering and cruelties inflicted on your people by the invader. Our two Countries stand together in this struggle, and we are confident that, with the united efforts of all those who realise the abyss to which Hitlerism is leading, tyranny will be overthrown and peace and justice prevail. It is our earnest hope that out of this strife and sacrifice will emerge a new order in which the prostitution of Science to the destruction of mankind will cease and men and women engaged throughout the World in the pursuit of Science will work together in amity for the benefit of the human race."

Biology and Health

AT the twenty-sixth annual general meeting of the British Social Hygiene Council, the president, Sir Walter Langdon-Brown, took for his subject the relation between biology and health. This address has been printed in the current issue of the organ of the above Society, *Health and Empire*. As an introduction he described the attempts that have been made by certain countries to degrade all the standards of learning and to stultify the search for scientific truth. Quoting from this year's report of the Rockefeller Foundation, Sir Walter explained how, all over Europe, the activities of the Rockefeller Foundation have been brought to a standstill. "The conception of knowledge as an international responsibility has vanished . . . as German forces have moved from one country into another a definite pattern has been followed." Where this was resisted, faculties were sent to concentration camps and student demonstrations were broken up with machine-guns and tanks. The rest of this story is too familiar to need reiteration. In 1932, *Pflugers Archivs*, the outstanding publication for seventy years in physiological and biological research, ran to five volumes. In 1938 it appeared as one slim volume. The *Münchener Medizinische Wochenschrift*, formerly one of the leading weekly medical journals in the world, has now become the happy hunting ground of cranks and naturopaths who hope to catch the Führer's eye. Yet the lamp of learning will never be extinguished, and Sir Walter went on to deal with particular examples of the way in which biology has made for improved conditions of health. The well-known work of the Rockefeller Foundation in controlling the spread of *Anopheles gambiæ* after its introduction to Brazil from Africa in 1930, and its almost complete —if not complete—eradication by 1940 was one of the more important examples that were considered.

Later, Sir Walter described the steps that will have to be taken to combat the ravages of venereal diseases. Although the causal organisms of these diseases have been known for many years, there is still in existence the 'hush-hush' policy which refuses to admit the cleansing light of understanding. The traditional opposition of the Victorians to any mention of sex matters in polite circles initiated a conspiracy of silence which is long a-dying. But this silence is being confronted by freer and franker discussion of sex matters among all classes. In this connexion the introduction of biological subjects with its objective approach to the study of reproductive physiology, in many schools and colleges, has played a noticeable part. The three main planks in the platform of the British Social Hygiene Council were outlined as follows: (1) The study of biology as a subject of general education; (2) the education of the educator; (3) general enlightenment on the principles of social hygiene. The remainder of the address was devoted to an amplification of these three problems and an account of the manner in which the British Social Hygiene Council is trying to grapple with them. A most heartening feature of the address was the statement that there has been no sensational rise in the incidence of venereal diseases in this War as there was in the last.

The University of Liverpool

THE annual meeting of the Court of the University of Liverpool was held on November 27, the Chancellor (the Earl of Derby) presiding. Lord Derby paid a high tribute to the work of the University throughout a difficult year in which the University buildings suffered considerably by enemy action. He recorded with pleasure, however, that the loss of life was fortunately slight, and that despite all difficulties, study has been maintained on a high standard. Sixty-five members of the teaching staff are now serving with the Forces or in Government Departments; the Senior Training Corps is strong; and the Air Squadron has grown considerably. The work of the Women's Training Corps has prospered, and the basic training in social service is well advanced. Thanks to the generosity and friendship of the City Council, the University is now receiving an annual grant which has reached the total of £25,000. By the generosity of Messrs. J. Bibby and Sons, the University has now been able to establish in Wirral a Veterinary Field Station under Prof. J. G. Wright.

The coming retirement of Prof. E. W. Marchant from the chair of electrical engineering was announced at the meeting. Mr. R. H. Armstrong, pro-chancellor, detailed the progress of the regionalization of the voluntary municipal hospitals, in which the University should become a focal point. He paid tribute to the research work of the University, affirming that through it, the national effort has received and would continue to receive a handsome dividend. His analysis of income and expenditure showed that the University finances are sound and that war conditions have imposed no undue burden upon student finances. The vice-chancellor (Dr. A. D. McNair) submitted his annual report, in which he emphasized the expansion of the Senior Training Corps and the part played by women students in national service. All women students were now required to engage in part-time national service.

British Standards Institution

THE British Standards Institution announces that, in view of the continuing expansion of the work of the Institution and the development of its relations with the Government Departments and with standardizing authorities overseas, the General Council has appointed an Executive Committee under a permanent chairman. The Executive Committee will keep all the activities of the Institution under review and report to the General Council from time to time as may be necessary. Mr. C. le Maistre, who has been connected with the movement almost since its initiation, and who for the past twenty-five years has been its chief executive officer, has been appointed full-time chairman of the Executive Committee, and Mr. P. Good, for several years deputy director and recently joint-director, has been appointed director and secretary of the Institution.

Bracken-infested Land for Potato Cultivation

BRACKEN-INFESTED land can be made very suitable to potato growing provided the proper methods of cultivation are used. Such land is normally light and would be easy to work if it were not for the formidable amount of roots and surface trash that must first be cleared. Trials (described by I. F. Trant, *J. Min. Agric.*, 48, 109; 1941) have been carried out on three areas near Welshpool to determine the best methods for preparing this type of land for a potato crop, and much valuable information has been obtained. Autumn ploughing followed by spring cultivation and immediate planting proved to be expensive and unsatisfactory, as the bracken roots prevented the proper working of the land. Gyrotilling in the spring after the ground had been 'predisked' killed off the bracken quite well, but it also was expensive and did not succeed in clearing the trash. A third method, however, though slower than the other two, gave most promising results and at considerably reduced cost. In this case the bracken was ploughed during June and July when it had attained its maximum growth and its reserve of food in the underground portions was at a minimum, a special device for burying the tall fronds being employed. The land was then worked and sown to rape, which was fed off to sheep during the autumn, thereby consolidating and manuring the ground. In the following spring, disk harrows and cultivators produced an excellent tilth, ploughing being omitted as it was likely to bring to the surface rubbish that was best left buried. Potato planting could then be satisfactorily carried out.

Electric Railways in the U.S.S.R.

IN the second of a series on "Transport in the Soviet Union", *Modern Transport* reviews the progress of railway electrification in Russia. It is stated that there were no electric railways in Imperial Russia. The Soviet began the electrification of the suburban lines in the Baku area in 1926 on the D.C. system at 1,200 v. with overhead conductors. In 1929, the 1,500 v. D.C. system was adopted with the inauguration of electric working in the Moscow suburban area, where up to 1926 electric traction was introduced on 112 route miles. In the Leningrad district, 44 miles of route underwent conversion during 1933–34. According to the *Electrical Review* of October 31, on these and certain other local lines in the Caucasus multiple unit passenger trains are employed. In 1932 a start was made with the electrification of certain main lines in mountainous and industrial areas, using the 3,000 v. D.C. system with heavy locomotives of three principal types for passenger, mixed traffic and freight trains. By 1939, electrified main lines comprised 828 route miles with an all-track mileage of 1,100 situated in the Caucasus, Ural, Donbass and Kussbass areas, and also on certain sections of the Murmansk line. Quite apart from the electrified suburban system in Moscow is the underground railway known as the Metro, which ranks not only as one of the newest, but also as one of the most lavishly carried out schemes of city transport in the world. It was authorized in 1931, and work began in 1932. By 1937 the Metro had 16·45 miles of route, and expansion was continuing.

Recent Earthquakes

ON the evening of November 25 an earthquake caused some apprehension in Lisbon and the surrounding country, though little material damage appears to have been done. Details of recordings from seismographic observatories are awaited before the exact epicentre can be determined. Several of these observatories report very large amplitudes. Fordham University (New York) reports the largest amplitudes since 1910; at Mr. J. J. Shaw's observatory at West Bromwich the recording levers were thrown out of their sockets; at Stonyhurst College Observatory the limits of registration exceeded the width of the paper; the shock was recorded at Kew and Oxford, though, according to Miss E. F. Bellamy, the amplitudes were not so great at the latter place.

On November 28 an earthquake of considerable severity was reported from Peshawar, Rawalpindi and Srinagar. No damage or casualties have been reported. Earthquakes in this district have not been uncommon in recent years and have been regularly reported by voluntary observers to J. M. Sil, representing the India Meteorological Department at Poona.

Announcements

AT the suggestion of Dr. G. Jedlewski, medical adviser to the Polish President, a special medical board has been formed in London to prepare plans for fighting epidemics which may break out in Poland at the end of the War.

A DIETETIC council has been set up in Ireland with Dr. P. T. O'Farrell to experiment on ways and means of aiding the people's nutrition under war-time conditions, paying special attention to the children's diet.

WE regret to announce the following deaths:

Dr. H. Ettringham, F.R.S., the well-known entomologist, president of the Royal Entomological Society during 1931–32, on November 26, aged sixty-eight.

Dr. Walcot Gibson, F.R.S., formerly director for Scotland, H.M. Geological Survey of Great Britain, on November 28, aged seventy-seven.

Dr. F. Stang, rector of the University of Oslo during 1921–27, president of the Nobel Committee of the Storting, who did much pioneer work in comparative research in human culture, aged seventy-four.

ERRATA. "Rigidity and Moisture Hysteresis in Gels", by W. W. Barkas, NATURE, November 22, p. 629. The following corrections should have been made in the MS.: (*a*) in equation (1), the upper limits of the integrals should read p and h_0 respectively; (*b*) in equation (2), the upper limits should read p_{k_0}, p_{n_0} and h_0 respectively; (*c*) seven lines below equation (1), for V read v.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. They cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

Colour Measurement

As was recently noted in NATURE[1], an increasingly high degree of accuracy in the specification of colour in terms of C.I.E. units is now being sought as a result of the growing realization of the indefiniteness of the colour discrimination limen and the low values it can assume in quite ordinary conditions. One would normally regard such circumstances as indicating in any physical quantity to be measured an ultimate need for correspondingly higher absolute accuracy, but it should not be overlooked in this case that higher discrimination is really called for in a quantity different from the one already standardized for use in colorimetry. The latter quantity, which is defined by the C.I.E. (1931) resolutions and data and will be denoted generally below by $\chi_{\text{C.I.E.}}$, refers to (*a*) a normal observer and (*b*) normal observing conditions, including particularly (*c*) a field of direct observation of 2° to which observations were necessarily intended to be restricted in order that they should apply to a region of uniform retinal structure and thereby have analytical significance.

The present position in colorimetry is due mainly to a growing recognition of the practical effect of varying sub-condition (*c*) by increasing the field size, which results in increasingly higher powers of colour discrimination. If we imagine the so-increased retinal field to be subdivided into smaller fields, we may reasonably assume that the same *form* of colorimetric analysis would apply for each, but the exact analysis for each and the method of reconstituting without loss the 'colour' as perceived, in a synthesized physical expression of it, remain subjects for future investigation. Certain it is, however, that this reconstituted colour would provide us with a new physical concept determined by a new quantity, χ_N say.

It is in the magnitude of this quantity that the higher precision is now really required. The individual quantities from which χ_N would be synthesized, considered in terms of any acceptable common units, might, of course, differ appreciably from one another in a yet unknown way, so that the problem of exact specification of colour as such, under the new varying sets of conditions, and to the higher accuracy called for, still awaits a final solution, which prevailing circumstances may postpone. If to some the need is urgent, one may—although without much justification—adopt as an expedient a procedure which, in fact, represents present practice, namely, identify conventionally, but nevertheless falsely, the colour magnitude $\chi_{\text{C.I.E.}}$ with χ_N, and ask of $\chi_{\text{C.I.E.}}$ the accuracy actually desired in χ_N.

True it is that, providing suitable standards exist and ageing effects therein can be controlled to the necessary accuracy, the light, the colour of which may be in question, might be spectrophotometered to an accuracy corresponding in itself to the accuracy of colour discrimination sought; but as will be clear from the foregoing, this does not satisfy the conditions of the problem except as an expedient. Some further important questions have, moreover, to be considered in this connexion, and it will be seen that, to the accuracy here in question, this procedure is only ultimately valid as a method of relative differentiation of colour magnitudes. For, first, we must notice that the C.I.E. data serving to define $\chi_{\text{C.I.E.}}$ were obtained from observations made upon a 2° field. It is, therefore, no criticism of these data to say that, considered in relation to the higher accuracy now being sought, residual errors of importance may be present therein. The reduction and tabulation of the original observations as so obtained cannot therefore be regarded as affording data of ultimate accuracy. Consequently, abnormal accuracy is not *a priori* justified at present in determinations of $\chi_{\text{C.I.E.}}$ as such. What signification can we attach to a quantity so perverted from its true nature as is $\chi_{\text{C.I.E.}}$ as currently adapted to new conditions in the above way? Clearly the actual sense in which it can be employed is not the truly physical sense originally intended as applying to the accepted normal observer but only an unreal and purely conventional one. It should therefore be recognized that, however this use of the adapted $\chi_{\text{C.I.E.}}$ may be justified as a practical device, a new term, $\chi'_{\text{C.I.E.}}$ say, differing from the original $\chi_{\text{C.I.E.}}$, has in fact been introduced by the simple act of adaptation, and has been employed in practice.

Secondly, we must notice that increased accuracy as such is not really directly called for, the specific need being for higher precision, not accuracy, of individual colour measurements in order to ensure the accuracy of differences in given circumstances. Standardization could not, of course, be ultimately dispensed with, but the immediate problem is clearly one of differential colorimetry, which is technically different from that of absolute colorimetry. Given a suitable standard, for use with a differential colorimeter, known in colour to an absolute accuracy within the degree of differential accuracy, δ_1, yielded by that instrument; then measurements, in absolute terms, of $\chi'_{\text{C.I.E.}}$ could be determined to any requisite accuracy limited only by δ_1. But if such a standard is not immediately forthcoming, the measurement merely of differences of $\chi'_{\text{C.I.E.}}$ to the same accuracy would still materially assist the colorist, and, if the effects of ageing could be controlled, possibly provide him, at least in some cases, with all he needs in this respect; for his interest in the absolute measurement of colour would then enter wholly or mainly through a consideration of colour differences which generally are so large as to render practically insignificant the small differences which are important in a differential sense.

Thus the present position is not entirely dependent upon the resolution of the outstanding problems of the ultimate standardization of colour. These present an important field for physical research, and incidentally provide material for an inquiry on philosophic method. The analytical nature of physical explanation imposes upon investigation formal conditions of method which, in the present case of colour, by securing accuracy of form have lost to us the essential precision in the substance of our observations.

Although this may be inevitable in the case of a directly estimated quantity of the type here in question[2], it has the form and effect of a paradox, the influence of which upon the progress of colorimetry as a branch of physical science it will be an important problem to remove, if the underlying nature of colour is to be made clear and if colour as a physical concept is to preserve and maintain its true and proper signification in the fullest possible sense.

It may be mentioned that these considerations are not put forward with the object of indicating academic propositions without effect upon the practical development of the subject. They affect directly its practical development in a fundamental sense, and arise in a manner unusual in physical investigation merely because of the unusual types of quantities and magnitudes with which we have at present to deal in the physical investigation of colour.

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[1] NATURE, 148, 506 (1941).
[2] *Proc. Phys. Soc.*, 53, 275 (1941).

Philosophy of Physical Science

THE recent discussion between Sir James Jeans and Sir Arthur Eddington [see NATURE of Oct. 25, p. 503 and earlier references], in so far as it involves the Fitzgerald-Lorentz contraction, prompts me to direct attention to an aspect of this matter which I presented recently before the American Physical Society Symposium on Philosophy and Science[1].

For many years I have maintained that the Michelson-Morley experiment has rather an illusory significance in relation to the theory of relativity and is, in fact, not fundamental to it[2]. There are, in fact, two aspects to the meaning of invariance under the Lorentzian transformation. The first, *A*, is a pure mathematical one and is concerned with the fact that if the equations are transformed from one set of variables to another by a Lorentzian transformation, they revert to the same form. The test of this is a pen and paper affair. The second aspect, *B*, implies all that is contained in the first and, in addition, the postulate that the second set of variables is that which an observer, moving with velocity v in relation to the origin of co-ordinates of the first system, would automatically use.

Suppose that in a system S I have a rod to which I impart a velocity v. In this process, all sorts of acoustical vibrations are set up. These die down in time, but how does the rod decide that it must settle down to a new length determined by the Fitzgerald-Lorentz contraction? The acoustical vibrations cannot be dismissed lightly, since they are part and parcel of the whole mechanism by which the rod received its motion. It seems that the quantum theory, if relativistically invariant in form, possesses the power to give the necessary answer.

According to the quantum theory, the form and stability of the rod at rest in S are determined by its being in a 'ground state'. Now if the equations are invariant in the sense *A*, we know that if we have, in S, one solution for, let us say, the Ψ function, satisfying the usual conditions of continuity, etc.; then associated with this solution we have an infinite number of other solutions obtainable from it by a Lorentzian transformation, and *these are all possible quantum states in the systems*. (It is quite true that on the aspect *B* any one of them would also be a quantum state in a system S' of measurements moving in relation to S with velocity v. I wish to make no use of this fact, however.) Any one of these states presents, of course, as one of its aspects, the picture of the rod moving along with a velocity which, measured in S, is equal to the value of v which occurs in the transformation, and the state can, therefore, by the quantum theory, be a possible state for such a rod. The ground state for the rod moving with velocity v is the state obtainable by a Lorentzian transformation from the ground state of the rod before the motion was imparted. It is, therefore, the state which the moving rod may be expected to assume unless the perturbation forces involved in the production of the motion are so large as to have produced the kind of quantum transitions of finite and, in general, large magnitudes which are associated with what we may call non-reversible changes in structure. In general, we may say that the kind of forces which are associated with the determination of structure are those characteristic of molecular affinity, and the quantum transitions necessary to produce non-reversible changes in structure are such quantum transitions as would be involved in molecular quantum transitions.

It thus appears that a relativistically invariant quantum theory, or something closely analogous to it, is a necessary supplement to the general principle of invariance of equations if we are to provide for the Fitzgerald-Lorentz contraction and for the customarily accepted form of the theory of relativity symbolized by what we have called the form *B*.

W. F. G. SWANN.

Bartol Research Foundation,
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Sept. 23.

[1] Held at Providence, R.I., June 21, 1941. The address and a special amplifying paper concerning the specific point in question are published in *Rev. Mod. Phys.*, 13, 190 and 197 (1941).
[2] Swann, W. F. G., *Phys. Rev.*, 35, 336 (1930); *Rev. Mod. Phys.*, 2, 243 (1930).

I HAVE terminated my correspondence on the philosophical controversy; but since Dr. Swann's letter deals with a purely scientific question regarding the relations of relativity theory and quantum theory, I venture to offer some remarks.

As Swann points out, the Lorentz transformation is no more than a mathematical change of variables unless it is coupled with a theory of the 'similarity' of the fixed and moving systems. I would remark, however, that the problem of similarity arises in physics at a much earlier stage, namely in defining a standard of length. Swann's question, how a rod decides its extension when it is given a different motion, is only part of the general question how it decides its extension when it is given a different location in space and time. Surely the answer is given by the law of gravitation, which definitely expresses the fact that the rod decides its extension by measuring itself against the local space-time curvature—that being the only linear characteristic available for comparison[1].

Dr. Swann's conclusions are reached in a general form if we adopt a more elementary starting-point. When we make statements about lengths in a remote star or at a remote epoch, it is implied that there

and then a physical standard (with the desired orientation and velocity) could be constructed 'similar' to a corresponding terrestrial standard; and the statements have no meaning unless we define the criterion of similarity. This is discussed rather fully in "The Philosophy of Physical Science" (pp. 73–85). It is concluded that the two standards must be constructed from a common specification; and the quantitative part of the specification must consist of *pure numbers* only, since it is required to precede the definition of length and all other physical quantities. This means that the specification must be a quantum specification; because it is only in quantum theory that a method has been developed of describing material structure by pure numbers—numbers of elementary particles the mutual arrangement of which is specified by quantum numbers. Thus appeal must be made to quantum theory for the definition of the interval *ds*, which is the starting-point of relativity theory.

Naturally the quantum theory must harmonize with relativity theory, and Dr. Swann is no doubt technically correct in saying that it must be relativistically invariant in form. But, as I have recently pointed out[2], this condition has been widely misunderstood and misapplied in quantum theory. It is often understood to mean that the equations should be Lorentz-invariant in form. But Lorentz invariance (or, more strictly, covariance) is no more than a special formula applicable when two systems, though considered in conjunction, are physically isolated—a condition rarely, if ever, arising in quantum problems. There is no more value in employing Lorentz-covariant equations in treating the internal structure of an atom or nucleus than in treating the internal structure of a star. 'Structural equations' are relativistically invariant as they stand, since they remain true whatever the motion of the body possessing the structure.

To come back to the original problem, if we suppose the fixed and moving rods to be calibrated by reference to the dimensions of hydrogen atoms sharing their respective motions, the rods will equally obey the Lorentz transformation whether the atoms are Dirac atoms or Schrödinger atoms. We have to go much more deeply into the general principles of relativity theory to obtain any useful guidance as to the form quantum theory must take.

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[1] "Mathematical Theory of Relativity", § 66, p. 152.
[2] *Proc. Camb. Phil. Soc.*, **35**, 186 (1939).

Physiology and Ecology of Cuticle Colour in Insects

THE interesting article in NATURE of October 11, p. 428, by Dr. Hans Kalmus requires comment upon a number of points, but first a protest must be entered against the use of the word 'frequently' in evidence for a 'rule'. Other vague statements might well be given more precise definition, such as 'pale' or 'dark'. The complications of pattern introduce great difficulties: Is an insect (non-lepidopterous, to fall in with Dr. Kalmus's excision of this group from most of the argument) with strongly contrasted areas of dark and light, conforming to the type of disruptive procryptic, or of aposematic, coloration, to be considered 'dark' or 'pale'? Dr. Kalmus's criteria would seem to be applicable only to unicolorous examples, or those of which the pattern gives a fairly uniform result, and thus must exclude immense numbers of insects.

The difficulties of applying Dr. Kalmus's 'rules' are great. For example, in the dry Ngamiland country of South Africa, I found large scavenging black Tenebrionid beetles running about in the hottest sun: equally large black and active predatory Carabids appear after dark, but another large predatory beetle, the black Cicindeline Manticora, hunts by day, as do a great number of its more brightly coloured relatives.

Among weevils, the hardness of many is proverbial, and experimental evidence by the late C. F. M. Swynnerton showed it to be decidedly of protective value. Yet some are 'pale', others 'dark'; some may be found freely exposed by day, others conceal themselves until night.

Among aquatic insects the Coleoptera might, on the whole, reasonably be classed as 'dark'. The much softer Hemiptera (Notonecta, Corixa, Naucoris) are 'pale', but the equally soft Nepa is very dark, or black. All may be found in the same pond. The explanation that dark cuticle is less easy to wet seems rather weak.

As regards the darkness of eggs, much more evidence is required. Contrast the dark eggs of the puss moth on willow leaves with the bright yellow eggs, on cabbage, of the cabbage white. The eggs of stick-insects (Phasmidæ) are notorious for their degree of cryptic resemblance to seeds in shape and colour: seeds are very often dark, and so are these eggs.

One would like to see figures in support of the statement that most non-black insects are found in the tropics: Are we to conclude that out of all non-black insects a majority occurs in the tropics, or that, of all insects in the tropics, a majority is non-black?

In connexion with the interesting point about liquid food, surely most aphids are not pale? One thinks of the black bean and dock aphids, and, at the moment, of a large bed of reed-mace, of which the leaves and stems are blackened with Aphis.

An interesting test of whether predators are darker than phytophagous species could be provided by a statistical study of two not widely separated families of Hemiptera—the predaceous Reduviidæ and the plant-sucking Coreidæ, which may be found side by side all over the world. Dr. Kalmus writes of the dark colour of the tse-tse fly. There are some twenty species of Glossina, and while some, such as *palpalis*, may be called 'dark', this term can scarcely be applied to *morsitans*. The former, inhabiting rain forest, can scarcely be said to be subject to the conditions of a dry region, while *morsitans*, in such a dry area as the Nuba mountains in southern Sudan, should be the darker species.

G. D. HALE CARPENTER.

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I AM pleased that my article should have aroused the interest of such a well-known authority on adaptative coloration as Prof. G. D. Hale Carpenter. Before answering in detail, I should like to deal with his first general protest. He objects to the word "frequently" in formulating a rule and calls this a "vague" statement. It is interesting in this context to quote from a letter which I received from Dr. B.P. Uvarov, of the Imperial Institute of Entomology,

which he kindly permits me to use: criticizing the wording of these same rules he writes: "The dogmatic character of your rules . . . is the first weakness of your paper." So I think I have on the whole kept well between extremes such as formulating rigid laws or merely making "suggestions for observation" as suggested in the letter quoted above.

If I understand Prof. Hale Carpenter's second sentence, he also thinks it vague to describe an insect as "pale" or "dark". In particular he thinks that the "complications of pattern introduce great difficulties". Actually I think it is quite feasible to assess the total brightness of an insect, for example, by using a photo-cell, and it is usually very easy to say which of two related forms is the darker one. Species with light and dark areas of cuticle are very useful for study. They provide the best material for a comparison of the properties of light and dark cuticles. I have been informed that such an investigation is in progress in a physical laboratory in Great Britain.

My article did not deal with pattern, but only with colour. Radiant heat, desiccation, or any of the five physical factors mentioned in my article do not have very different effects on an insect, whether homogeneously coloured or speckled, provided it has the same total brightness.

Many of Prof. Hale Carpenter's points seem to me to be the kind of exceptions which prove the rules. I think the beetles of Ngamiland provide quite good examples for Rules 12 and 14 (drought and vagility). They are mostly conspicuously black, and the more brightly coloured Cicindelids may well show a metallic colour. A comparison of the colour and life-habits of weevils may be worth while, but as both the light and the dark forms are very hard, a different process of hardening seems to be at work.

I think Rule 11 can only be understood to mean that the proportion of non-black insects is greater in the tropics. Similarly, Rule 13 means in respect of the aphids that a high percentage of them is light. The cuticle of the black aphids, mentioned by Prof. Hale Carpenter, is quite light; only the body contents and the epidermal cells are pigmented. This can easily be demonstrated by pressing a black aphid (for example, the chrysanthemum aphid, *Macrosiphoniella sanborni*) between two bits of filter paper. The result is two dark spots and a hyaline cuticle. The colour of the Reduvidæ and Coreidæ would not seem to have much bearing on the problem, since they are also hemimetabolic insects (Rule 5) and probably most of their coloration is not situated in the cuticle. It would be interesting to find out whether the same is true of Nepa.

It is difficult to see what selective advantage can be ascribed to the notorious resemblance of the eggs of Phasmidæ to seeds. On the other hand, I think it is not surprising that an embryo, whether plant or insect, which has to resist the vicissitudes of a very similar environment, should show similar features. To my knowledge the humidity on a willow and a cabbage leaf have not yet been compared; but perhaps the fact that the puss moth has only one generation a year, whereas cabbage whites have several, could be interpreted by means of Rule 9.

I used a dark tse-tse fly merely as an example to show the difficulty in some cases of detecting the controlling factor in coloration, and I quite agree with Prof. Hale Carpenter's remark in his second paragraph, that the difficulties in applying my rules are great. However, they are not greater than in any other new ecological subject. That the "ecogenotypical colour variation" of insects is indeed beginning to attract the interest of biologists appears not only from correspondence on the subject, which I receive almost daily, but also from a paper, which reached me after my article had been written, and from which the term "ecogenotypical" is taken (W. Hovanitz, *Ecology*, July, 1941). It deals precisely with the group of insects which I thought would offer the greatest difficulties for the application of my rules, namely with butterflies. Although in disagreement with some of my rules, Hovanitz concludes from the study of many species that "contrary to established dogma the adaptiveness of animal coloration need not only be 'protective' but may only be a secondary product of a more fundamental function in the physiology of the animal". He thinks further that the geographical centres of pigmentation "are shown to be centres of certain physical conditions such as aridity, high temperature, etc., though they might more specifically have been said to be centres of low precipitation, low humidity, high temperature, high solar radiation, fast animal development and light coloured soil".

H. KALMUS.

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Number of Primes and Probability Considerations

IN the first sentence of Lord Cherwell's communication[1] occurs the phrase "a number chosen at random"; and the applicability of the theory of probability surely depends on the possibility of random choice. Now an integer can be chosen at random from any finite set, but there is no way of choosing one at random from the infinite set of all positive integers. Thus if Lord Cherwell chooses an integer "at random" it will certainly be less than $10^{10^{10}}$, as otherwise he will not live long enough to write it down. But the probability that an integer chosen at random is less than $10^{10^{10}}$ is zero.

Hence, though we may use probability theory heuristically in the theory of numbers, and although it sometimes gives correct results, we have no logical grounds for supposing it will do so. Perhaps a set of axioms could be produced which would enable us to apply probability theory, but such a set would not, I think, include the phrase "a number chosen at random". Until this is done it is not obvious where to look for the weak link in the chain of reasoning when probability theory gives an incorrect result. We can, of course, apply probability theory to everywhere-dense infinite sets, such as the real or algebraic numbers in an interval, but in this case we never deal with an individual number, but only with a sub-interval. We biometricians have our difficulties, but at least the number of men, or even of bacteria, is finite, so biometrical sampling theory can be given a comparatively secure logical basis.

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[1] NATURE, 148, 436 (1941).

In NATURE of October 11, p. 436, Lord Cherwell calculates, by considerations of probability, the number of primes in an interval Δ and finds that the correct answer is about 11 per cent smaller than his results.

Having myself calculated the number of primes by the probability method some time ago, I think I can give an explanation of the difference.

The probability for a number to be prime

$$\bar{\omega}_n=(1-\tfrac{1}{2})\,(1-\tfrac{1}{3})\,(1-\tfrac{1}{5})\,(1-\tfrac{1}{7})\,(1-\tfrac{1}{11})\;\ldots\left(1-\frac{1}{p_n}\right)$$

is valuable only for the whole interval between p_n and $(p_{n+1})^2$. But Lord Cherwell applies it—or one derived from it—to an interval which is only part of the preceding. And the different parts of the $p_n-(p_{n+1})^2$ interval are not equally rich in primes. The higher parts are comparatively poor in primes. Thus, applying to the higher parts of the interval a formula which is valuable only for the comparatively richer whole interval, Lord Cherwell very naturally finds a number of primes which is slightly too great.

On the contrary, when the formula is applied to the correct interval $[p_n$ to $(p_{n+1})^2]$ the agreement becomes rapidly very good as p_n increases, as is shown by the accompanying table.

Of course the probabilities of divisibility are strictly independent and it cannot be any question of a mysterious tendency of the factors to avoid each other.

A FREE FRENCH SCIENTIST.

October 13.

"A FREE FRENCH SCIENTIST" appears to use the word 'probability' in an unconventional sense. The probability that a number in the neighbourhood of a large number A should be a perfect square tends to $\frac{1}{2\sqrt{A}}$; this is an obvious property of numbers in the neighbourhood A; it is not a matter of intervals. A "Free French Scientist's" expression does not give the probability of a number in the neighbourhood of a large number N^2 being prime, but the average value of the probabilities between p_n and $(p_{n+1})^2$.

The agreement he finds is unfortunately spurious. According to well-established theory the number of primes in his interval would be approximately $\mathrm{li}\,(p_{n+1})^2-\mathrm{li}\,p_n$. In the region he has examined in his table this happens to be about 10 per cent bigger than $\frac{p_{n+1}}{2\log p_{n+1}}$ and therefore nearly equal to $\frac{p_{n+1}}{e^{\gamma}\log p_{n+1}}$. But this is because he chanced to stop at 97. If he had proceeded to larger numbers the agreement would vanish and he would find a discrepancy just as serious as the one to which I directed attention.

Incidentally, my use of the word 'avoid' seems to trouble the "Free French Scientist" unnecessarily. Perfect squares avoid one another more and more the further we go, but there is nothing mysterious about this.

While I can sympathize with Prof. Haldane's very human wish to begin a metaphysical discussion, I had not expected him to reveal the urge quite so soon after his letter extolling utilitarian studies as opposed to pure science. Unfortunately, I do not feel I ought to indulge him, since his difficulties are quite irrelevant to the point at issue. The discrepancy to which I directed attention can be derived perfectly well by choosing a number at random from a finite class.

CHERWELL.

Christ Church,
Oxford.

Prime numbers		Interval	Probability of being prime for a number in the interval Δn	Number of primes in the interval Δn		Difference %
P_n	P_{n+1}	$\Delta n=(p_{n+1})^2-p_n$	$\bar{\omega}_n=(1-\frac{1}{2})\,(1-\frac{1}{3})\,(1-\frac{1}{5})\;\ldots\left(1-\frac{1}{p_n}\right)$	Calculated by $N=\bar{\omega}_n\Delta$	Actual	
2	3	9 − 2 = 7	0·5	3·5	3	+16·7
3	5	25 − 3 = 22	0·3333 . . .	7·333 . . .	7	+ 4·6
5	7	49 − 5 = 44	0·2666 . . .	11·733	12	− 2·2
7	11	121 − 7 = 114	0·2286	26·055	26	+ 0·2
11	13	169 − 11 = 158	0·2078	32·830	34	− 3·4
13	17	289 − 13 = 276	0·1918	52·936	55	− 3·8
17	19	361 − 17 = 344	0·1805	62·097	65	− 4·5
19	23	529 − 19 = 510	0·1710	87·216	91	− 4·2
23	29	841 − 23 = 818	0·1636	133·80	135	− 0·9
29	31	961 − 29 = 932	0·1579	147·20	150	− 1·9
31	37	1369 − 31 = 1338	0·1528	204·50	202	+ 1·2
37	41	1681 − 37 = 1644	0·1487	244·02	244	+ 0·008
41	43	1849 − 41 = 1808	0·1455	263·01	262	+ 0·4
43	47	2209 − 43 = 2166	0·1421	307·77	307	+ 0·25
47	53	2809 − 47 = 2762	0·1391	384·10	385	− 0·25
53	59	3481 − 53 = 3428	0·1364	467·71	461	+ 1·5
59	61	3721 − 59 = 3662	0·1341	491·18	491	+ 0·03
61	67	4489 − 61 = 4428	0·1319	584·18	580	+ 0·7
67	71	5041 − 67 = 4974	0·1300	646·43	646	+ 0·07
71	73	5329 − 71 = 5258	0·1281	673·70	673	+ 0·1
73	79	6241 − 73 = 6168	0·1264	779·47	777	+ 0·3
79	83	6889 − 79 = 6810	0·1248	849·70	848	+ 0·2
83	89	7921 − 83 = 7838	0·1233	966·18	966	+ 0·02
89	97	9409 − 89 = 9320	0·1219	1136·0	1129	+ 0·6

Penetration of a Water-soluble Sulphonamide, Sodium Sulphacetamide (Albucid-soluble) into the Eyes of Rabbits

RECENT work has shown that the local application of sodium sulphacetamide can control the development of experimental corneal ulcers in rabbits (Robson and Scott[1]). This sulphonamide is also being used clinically in concentrations up to 30 per cent for the treatment of various ocular infections, and especially of hypopyon ulcers, and it became of interest to determine the concentration attained in the various ocular tissues, when solutions are applied locally to the conjunctival sac.

Experiments were performed on twenty-eight mature rabbits. Under ether anæsthesia; celluloid

funnels were put into one or both eyes and kept in position by means of purse string sutures through the lids (see Fig. 1). The funnel was so designed that its aperture had a diameter greater than that of the cornea. The flange therefore lay against the conjunctiva overlying the sclera, and no part of the funnel was in contact with the cornea. The solution of sodium sulphacetamide (2·5 or 30 per cent) was poured into the funnels and allowed to remain in contact with the eye for periods ranging from 5 to 30 min. The eyes were then removed, washed in saline and rapidly dried on blotting-paper. The aqueous humor was then withdrawn and the tissues dissected off, washed in saline and rapidly dried on blotting-paper.

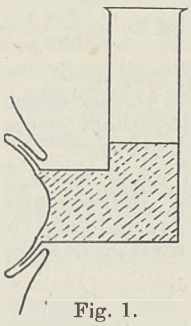

Fig. 1.

DIAGRAM TO SHOW POSITION OF FUNNEL IN CONJUNCTIVAL SAC.

The sodium sulphacetamide content of the tissues was then determined colorimetrically by the method of Marshall and Litchfield[2], with slight modifications. The results are shown in Figs. 2 and 3.

Each point on the graphs represents the mean of the values obtained in 5–10 experiments. There was considerable individual variation but certain facts nevertheless stand out quite clearly.

The concentrations in the cornea and conjunctiva are very similar and much higher, as was to be expected, than that found in the aqueous. The values for the iris were still smaller. The drug penetrates into the cornea and conjunctiva very rapidly and very high concentrations can be produced, either by applying the 30 per cent solution for a short period, or by applying the 2·5 per cent solution for longer periods.

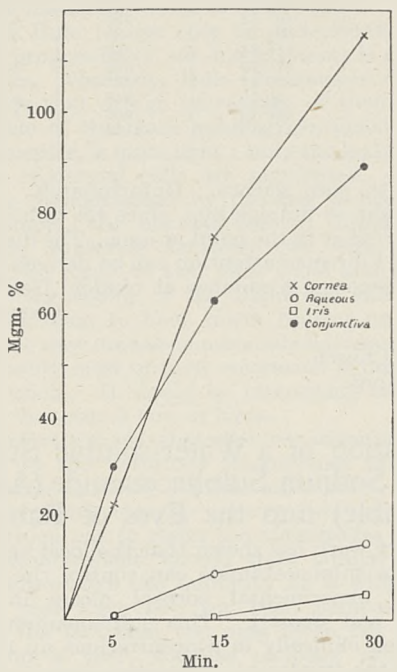

Fig. 2.

CONCENTRATIONS OF SODIUM SULPHACETAMIDE (MGM. %) ATTAINED IN OCULAR TISSUES AT VARIOUS PERIODS AFTER THE BEGINNING OF APPLICATION OF A 2·5 PER CENT SOLUTION OF THE DRUG TO THE CONJUNCTIVAL SAC.

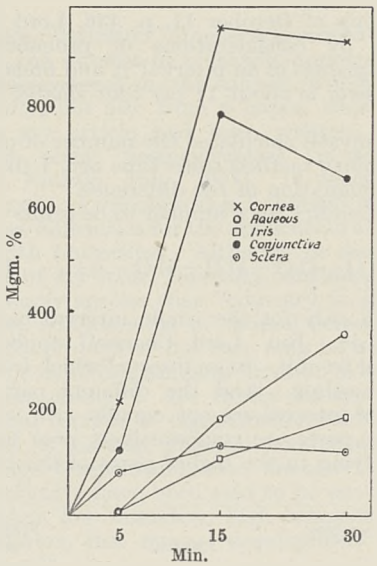

Fig. 3.

CONCENTRATIONS OF SODIUM SULPHACETAMIDE (MGM. %) ATTAINED IN OCULAR TISSUES AT VARIOUS PERIODS AFTER THE BEGINNING OF APPLICATION OF A 30 PER CENT SOLUTION OF THE DRUG TO THE CONJUNCTIVAL SAC.

Application of the 30 per cent solution (which is hypertonic) for fifteen minutes or more produced some degree of œdema of the cornea, and this may be responsible for the failure of the concentration of the drug in the cornea to rise any further.

Only small amounts of the drug were found in the vitreous humor and there was practically no penetration of the drug into the lens. In a number of experiments the concentration of the drug in the blood was determined. The highest value obtained was 7 mgm. per cent after the application of the 30 per cent solution for 30 min.; but in most cases it was much smaller. These low values show that direct penetration of the drug was responsible for the high values found in the ocular tissues.

These results, like those of P'an[3], suggest that local application of sulphonamides is the method of choice for the production of adequate concentrations of the drug in the ocular tissues and for the treatment of certain ocular conditions by sulphonamides.

The expenses of this investigation have been defrayed by the W. H. Ross Foundation for the Prevention of Blindness. We are greatly indebted to Mr. Edwards of British Schering Ltd. for the supply of a 30 per cent solution of albucid soluble.

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[1] Robson, J. M., and Scott, G. I., NATURE, 148, 167 (1941).
[2] Marshall, E. K., and Litchfield, J. T., *Science*, 88, 85 (1938).
[3] P'an, S.Y., *Proc. Soc. Exp. Biol.*, 46, 31 (1941).

RESEARCH ITEMS

Ancient Indian Cultures

AN article by M. E. and D. H. Gordon (*J. Roy. Asiatic Soc. Bengal*, 6, No. 2 ; 1940) contains interesting information concerning their studies in the Indus valley. The prehistoric cultures exemplified by Harappa and Mohenjo-daro are not necessarily isolated from those of the early historic period, as certain objects have been found in mounds in Peshawar and other neighbouring districts which appear to carry on the ancient traditions. Moreover, painted pottery such as is found in these mounds is made in all the same localities to this day. This does not mean that there is no distinction between the present-day painted pots and those of the early historic periods ; but there are certainly similarities, which, with the other evidence put forth, tends to show that there is no hiatus of 2,000 years in these Indian cultures. Ancient metal and stone workings in the eastern portion of Chota Nagpur have been excavated by E. F. O. Murray and described in "The Ancient Workers of Western Dhalbhum" (*ibid.*). The ethnology and geology of the district are dealt with briefly and a description given of the very interesting finds of pottery, beads and stone implements. The old mines are also described. The author concludes that they belong to an ancient culture of a higher level than that attained by the present inhabitants of the region.

Nicotine Accumulation in Reciprocal Grafts of Tomato and Tobacco

THE distribution of nicotine between stock and scion in reciprocal grafts of tomato and tobacco was described by R. F. Dawson at the Autumn Meeting of the U.S. National Academy of Sciences held during October 13–15. When tobacco scions were grown upon tomato stocks no appreciable amounts of nicotine accumulated in the tobacco leaves or stems. In fact, the nicotine which was originally present in the scions remained in the lower leaves and stems, and the leaf and stem tissues which afterwards developed were nicotine free. When tomato scions were grown upon tobacco stocks nicotine was found in appreciable quantities in the tomato stems and fruits, and large quantities of the alkaloid accumulated in the leaves. Nicotine accumulation in the leaves of the tomato scions was sectoral when tobacco stems were decapitated and inserted into the tomato stems unilaterally. Nicotine was isolated from the xylem and the xylem sxudate of the stems of intact tobacco plants. The evidence indicates that the presence of nicotine in tobacco leaves is due to (*a*) the synthesis of the alkaloid in the tobacco roots, (*b*) the translocation of the fully formed base (and not its precursor) to the leaves by way of the xylem, and (*c*) the continued accumulation of this nicotine in the leaves.

Microscopic Structure of the Wool Fibre

A SERIES of twenty-seven microphotographs forms a special feature of a study of the fine details of structure of wool fibres by C. W. Hock, R. C. Ramsay and M. Harris (*J. Res. Nat. Bur. Standards*, Washington, D.C., 27, 181 ; 1941). Special attention was given to constituent scale and cortical cells. The individual cells were released by treating chemically modified wool with pepsin. The striated appearance of the cortical cells is due to the presence of many fibrils which can be separated with microneedles. Between crossed nicols the fibrillar part of the cortical cells appears birefringent whereas the nucleus does not. The scales show little internal organization and appear non-birefringent between crossed nicols. A comparison of root and shaft of the fibre reveals many differences in reaction to microchemical colour tests as well as differences in cellular structure. The paper can be obtained also as Research Paper *R.P.* 1412 [10c] from the Superintendent of Documents, Washington, D.C.

Heat of Sublimation of Carbon and Absorption Bands of Three Mesomeric Hydrocarbons

SPECTROSCOPIC analysis of the CO spectrum, together with thermochemical measurements on the burning of carbon in oxygen, lead to the conclusion that L, the heat of sublimation of carbon, is either 124 or 170 kcal./mol. G. J. Kynch and W. G. Penney (*Proc. Roy. Soc.*, A, 179, 214 ; 1941) have made an estimate of L by calculating the energies of excited states of benzene, butadiene and hexatriene. Various values of L were assumed and the calculations were compared with experiment. Almost exact agreement was found for all three substances by assuming $L = 170$, and no agreement was found by assuming $L = 124$. The theory used is similar to that developed by Eyring for estimating activation energies. The equilibrium internuclear distances in the excited states are found, and the potential function controlling some of the vibrations about these positions is determined. The excited state of benzene has the regular hexagon configuration, with the carbon-carbon internuclear distance 1·45 A., compared with 1·39 A. in the ground state. The carbon-breathing frequency in the excited state is calculated to be 920 cm.$^{-1}$, compared with the experimental value 940 cm.$^{-1}$.

Preparation of Deoxycholic Acid

THE preparation of deoxycholic acid from cholic acid was described by T. F. Gallagher and W. P. Long at the Autumn Meeting of the U.S. National Academy of Science held during October 13–15. When methyl cholate is oxidized at low temperatures with chromic oxide, the principal product is the methyl ester of 3-12-dihydroxy-7-keto-cholanic-acid, hitherto undescribed. A method for separation of this compound is given. Upon reduction by the method of Wolff-Kishner it is converted smoothly to deoxycholic acid in excellent yield.

Structure of Soap Curd Fibres

SOME interesting photographs of the curd fibres of sodium laurate have been obtained by L. Marton, J. W. McBain and R. D. Vold (*J. Amer. Chem. Soc.*, 63, 1990 ; 1941) by means of the electron microscope with direct magnification up to 19,000 diameters. The results confirm previous conclusions based on less direct evidence. The curd is shown to consist of a mass of fibres which are thin ribbons with widths tending to be integral multiples of approximately twice the length of the sodium laurate molecules. In order that the carboxylate groups and methylene groups, respectively, may be adjacent to one another

in the manner found by X-rays for the monoclinic crystals, it would be expected that the fibres should be much wider than they are thick, and this agrees with the microscopic result. The fibres branch to form a felt, which accounts for the rigidity of the curd. The fibre junctions are also seen to give rise to many capillary spaces of variable diameter in which water can be retained, even at very low relative humidity. Some of the sodium laurate apparently is not a part of the fibrous structure but is present in granules 100–200 A. in diameter irregularly spaced along the fibre. These were perhaps formed by rapid dehydration, during exposure of minute drops of solution, or may be related to aggregates pre-existing in the soap solution.

Effect of Ions on the Liquid Structure of Water

G. W. STEWART, in a paper read at the Autumn Meeting of the U.S. National Academy of Sciences held during October 13–15, discussed the effect of ions on the liquid structure of water. Water is unique in its liquid structure, and the influence of ions in solution on this structure becomes important experimental evidence. The results represent a considerable extension of an earlier report, and the conclusions therefrom are as follows: (1) With 41 strong electrolytes (so named in I.C. tables), out of a possible of approximately 200, the alteration in the X-ray diffraction pattern indicated that the ions caused an increase in the co-ordination bonds of the solvent water with a contraction in its volume. (2) With 37 of these, there was a rough but striking correlation between the rate of change of apparent molal ionic volume with concentration and the rate of change of the X-ray structure with concentration, the latter being determined in a somewhat arbitrary but consistent manner. The number of electrolytes was limited by the desirability of using only the lighter atoms. (3) With 3 of the strong electrolytes the rate of change of the apparent molal ionic volume occurred in the opposite direction although the change in water structure was similar to that with the others. The conclusion is that there are other factors in these special cases (the total number is only 6 in 200) which have the effect of decreasing the apparent molal ionic volume. Quantitatively, ionic temporary pairing might be such a factor. (4) There is a rough correspondence between the solubility of these electrolytes and their effect upon the structure of the water, the less the effect on the structure the greater being the solubility. (5) All these results are consistent with and seem to emphasize the tetrahedral structure of water changing with increasing temperature, this structure and these changes accounting for some of the unique characteristics of water.

New Compounds Fluorescent to X-Rays

NEW compounds fluorescent to X-rays consisting of pure isomorphous mixtures of the sulphates of barium and lead, have been discovered in the research laboratories of Ilford Limited by F. F. Renwick and H. S. Tasker, and form the subject matter of a recently issued British Patent No. 540,252. These materials, it is claimed, emit a strong violet and ultra-violet fluorescence, without afterglow when excited by X-rays, but show no fluorescence under ultra-violet light illumination. Being insoluble and inert towards photographic emulsions, they are likely to prove valuable, not only for the manufacture of X-ray intensifying screens, but also in composite units embodying both screen and emulsion on a single support. They appear, moreover, to be unique in that they can be prepared by double decomposition in an active micro-crystalline form by the simple interaction of a solution containing salts of barium and lead with a solution of a sulphate, without the necessity for a subsequent firing treatment, as is essential in the preparation of all the well-known fluorescent salts, such as calcium and other tungstates, zinc sulphide and zinc silicate. When a firing operation is also employed, their fluorescence is stated to be considerably enhanced, and products rivalling the most highly fluorescent calcium tungstates are said to be obtainable. This addition to the list of useful fluorescent compounds will doubtless interest not only radiologists but also those research workers who make a special study of fluorescence phenomena.

Bombardment Experiments with Protons on Boron

WHEN boron is bombarded with protons, two groups of α-particles are found, one a group with continuous distribution in range and maximum range of 3·7 cm., the other a group with homogeneous range of 4·4 cm., according to A. Ellet and J. Jacobs in a paper read at the Autumn Meeting of the U.S. National Academy of Sciences held during October 13–15. The excitation function of each group was studied in the range 100–200 kev., and in each case showed a resonance at 158 ± 3 kev. The resonance for the continuous group had not been previously found. The distribution in angle of each group at resonance and of the continuous group just above resonance (175 kev.) was measured. Both groups showed asymmetry at resonance (in agreement with previous reports); but the continuous group was observed to possess spherical symmetry above resonance (in contradiction to previous reports). The resonance yields of the α-particles of each group are presumed to have a common origin, a p- or d-proton capture. The non-resonance yield of the continuous group is presumed to arise from an s-type capture. The results are in agreement with certain theoretical considerations.

Maxima of Absorption Lines in Stellar Spectra

THE maxima of absorption lines in stellar spectra were described by P. C. Keenan at the Autumn Meeting of the U.S. National Academy of Sciences held during October 13–15. The accurate spectral types recently determined at the Yerkes Observatory for a large number of stars provided the basis for improved estimates of the spectral types (and corresponding effective temperatures) at which the stronger atomic lines and molecular bands reach their maximum intensity. In giant stars the neutral iron lines of *e.p.* 1·5v. show a maximum at type $K5$ ($T_e = 3600° \pm$) while those with *e.p.* 2·4v. are strongest near $K3$ ($T_e = 3850° \pm$). In dwarfs the behaviour of these lines is similar but less clearly differentiated. Among the lines of ionized elements which persist to low temperatures, the K-line of Ca + shows no marked falling off in strength through the coolest observable giants (type $M5$ with $T_e < 3000°$), but has a maximum for the dwarf stars near $K5$. Bands of CN are strongest at $K1$ in giants and at $G7$ in supergiants, while remaining weak in dwarfs at all temperatures. The λ4300 band of the CH molecule behaves similarly, but has maxima about five spectral subdivisions earlier than those of CN.

MEDAL AWARDS OF THE ROYAL SOCIETY*

Copley Medal

THE Copley Medal has been awarded to Sir Thomas Lewis.

Lewis's life's work, still in vigorous progress but for interruption by war duties and war conditions, has been the application of precise and controlled methods of experimental research to problems of clinical medicine. This has enabled him to achieve a detailed analysis of abnormalities of function produced by disease, injury or hereditary defect; and so far his attention has been centred upon the circulation of the blood and its disorders. Being attracted through the work of the late Sir James Mackenzie to the study of abnormal rhythms of the human heart-beat, Lewis recognized, about 1908, the great opportunity for a closer investigation of them offered by the then recent introduction of the string galvanometer by Einthoven. With its aid Lewis had soon made a number of clinical and laboratory studies, such as those in which he finally identified auricular fibrillation as the cause of a particular kind of complex irregularity. He was thus led to undertake, and to extend, with a succession of collaborators from many countries, the remarkable series of investigations, carried through in logical sequence between 1910 and 1923, in which he passed from the laboratory to the clinic and back again as the occasion demanded.

It is fitting that special mention should here be made of the series of experimental studies published in the *Philosophical Transactions* during 1914–1916, and presented in brilliant summary by Lewis in his Croonian Lecture to the Society in 1917. In these were traced, with an astonishing precision of measurement and timing, the point of origin and exact course of the rhythmical waves of excitation and contraction in the normally beating heart of the dog, and, finally, for comparison, in the hearts of other classes of vertebrate animals. Considered by itself, this work ranks as one of the outstanding achievements of experimental physiology in our times, and it has given to physiology a large part of its present detailed knowledge of the nature of the heart-beat. For Lewis, however, its greater importance lay in giving to clinical medicine the background for an accurate picture of disturbances of the normal mechanism, therewith a new security of diagnosis and prognosis in dealing with disordered actions of the heart, and ultimately a rational basis for their treatment. A new phase of cardiological thought and practice spread rapidly from Lewis's clinic round the world.

Meanwhile he had begun in 1917, and was to maintain with a series of collaborators for more than another decade, a separate series of investigations, dealing by direct experiment with the blood vessels of the human skin. Thus were elucidated the means by which the resistance of these vessels to the flow of blood is maintained and varied, including their complex reactions to chemical substances akin to histamine, which he proved to be released from the cells of the epidermis by injuries or irritant stimuli. These methods of investigation were later developed and extended to vascular disorders of the limbs, and the experiments of still more recent series have dealt with pain and functional defects in muscles and nerves, due to interruption of the blood supply. Apart from the separate accounts of items and stages of these lines of research, as completed, in papers which have issued from his department in steady sequence, Lewis has assembled and discussed the results, in their appropriate connexions, in a succession of comprehensive monographs. He has been the inspiring leader of a group of younger workers in clinical research as an experimental science, has founded a Society for such studies and has devoted to their use a journal which he had started with a more limited scope.

The work of Thomas Lewis, which we honour today with the highest recognition in the gift of the Royal Society, is renewing and carrying forward, with a special directness, the great tradition which William Harvey created, before this Society was founded.

Royal Medals

A Royal Medal has been awarded to Prof. Edward Arthur Milne.

Milne is distinguished for his work on planetary and stellar atmospheres, on the internal constitution of the stars, and on the theory of relativity. An early paper on various properties of the earth's atmosphere, up to high levels, led later to a valuable improvement of the theory of the escape of planetary atmospheres by the passage of the faster moving molecules out of the range of the gravitational field. Thence he passed on to a long series of investigations on radiative equilibrium and the theory of the atmospheres of the sun and stars.

Next, partly in collaboration with R. H. Fowler, he improved and extended Saha's theory of the absorption lines in stellar spectra, obtaining a relation between the maximum strength of a line and the mean pressure and temperature in the atmosphere. Afterwards Milne generalized this theory, providing a rational foundation for the astronomers' empirical method of determining stellar parallaxes from the spectra.

Later he considered the equilibrium of the calcium chromosphere of the sun, and also discovered a method by which outward-moving atoms capable of absorbing radiation in the region of the chief absorption lines can be accelerated and pass beyond the range of the sun's attraction, attaining a limiting speed of about a thousand miles a second. This theory also has an application to 'new' stars.

Milne then considered the deeper layers of the atmosphere (for example, in the case of the sun, the photosphere), which in 1929 he took as the subject of his valuable Bakerian Lecture. He has also given a theory of the structure of sunspots and of the circulation associated with them.

In 1929 he began a new series of researches on the radiative equilibrium of gas spheres, designed to improve the theory of the internal constitution of the stars. His work in this field was specially important in focusing attention on the properties of degenerate matter.

In 1932 Milne began an altogether different series of investigations, bearing on the largest topics of astronomy and cosmogony, and providing an alternative

* From remarks made by Sir Henry Dale in presenting the medals for 1941.

to the general theory of relativity developed by Einstein and his followers. He has made a valuable analysis of the concept of time, and his kinematical theory of gravitation has some promise of a possible extension to include also electromagnetism.

Milne's later work has been the subject of much controversy: but the originality and boldness of his attack seem certain to promote our understanding of these great problems.

A Royal Medal has been awarded to Prof. Ernest Laurence Kennaway.

Kennaway is the director of the Chester Beatty Research Institute of the Royal Cancer Hospital, and has been engaged for the past twenty years in investigations on the production of cancers by the continued effects of chemical agents. The long-known liability to skin cancer of men whose work involves regular contact with soot, coal tar, or pitch, and the more recently demonstrated production of such cancers in animals by painting the skin with tar, had raised the question whether a specific chemical agent was concerned, or only a sufficiently persistent irritation. The fractionation of coal tar, in search of a substance revealing its action only after tedious months of experiment, was an undertaking to daunt any but a devoted investigator. Kennaway embarked on this quest, and after years of labour the fluorescence studies of his co-workers Mayneord and Hieger made it possible to isolate a pure substance from tar with intense carcinogenic activity, and ultimately to identify it as benzpyrene. This identification and its confirmation by synthesis were due to J. W. Cook.

Meanwhile, the observation that active fractions of the tar had ultra-violet fluorescence spectra resembling those of hydrocarbons of the phenanthrene type, led to the synthesis of substances with carcinogenic activity. The first of these was a dibenzanthracene, and was found to be almost as active as benzpyrene. Substances of still greater activity have since been obtained, and some of these have a close structural relationship to naturally occurring sterols. A characteristic nuclear ring-complex thus, surprisingly, provides a link of structural community between these carcinogenic agents and a number of natural substances having intense but widely different biological activities—the D vitamin, a number of hormones concerned with sexual functions, and the highly toxic but remedially important glucosides of the digitalis series. One of the most fascinating chapters in organic and biological chemistry has been opened. Identification of these provocative agents does not tell us how they act, and the causes of seemingly spontaneous cancers remain as yet obscure. It cannot be doubted, however, that, when further advances of knowledge enable a correct account to be written of the nature and mode of origin of the malignant tumours, the pioneer work of Kennaway and his able group of co-workers will provide one of the important chapters.

Davy Medal

The Davy Medal has been awarded to Dr. Henry Drysdale Dakin.

Dakin began his researches in the field of biochemistry early in the present century. At that time, in comparison with knowledge of the end-products of metabolism, relatively little was known about the chemical activities of the living cells of the animal body. His work has made very important additions to knowledge of the intermediary changes produced by these activities, and also of the chemical structure of natural components of the tissues.

One side of Dakin's work has dealt with enzymes of the animal organs. He was the first to show that such an enzyme will attack at different rates the two optical isomers in a racemic mixture. With Kossel he discovered the enzyme arginase, with its important role in the production of urea from arginine. Later he discovered the enzyme glyoxalase, the wide distribution of which in the tissues must indicate some important though still undefined function in carbohydrate metabolism.

In connexion with the intermediary metabolism of fatty acids, Dakin produced the first convincing evidence of oxidation at the β-carbon atom as the first stage of their utilization by the body, and showed that this type of oxidation can even be reproduced *in vitro* by the action of hydrogen peroxide.

Dakin's work on the chemistry of the proteins has included a method of partial racemization, bringing subtle differences of molecular pattern into view, which could be related to specific antigenic differences. He also introduced a method of separation which enabled new hydroxyamino acids to be recognized, and raised much nearer to unity the proportion of a protein molecule accounted for as known amino-acids. At a wide interval of years, Dakin has made two notable contributions to the chemistry of hormones. In 1905, he was resonsible for the first published artificial synthesis of a hormone, adrenaline. In 1936 he described the isolation from liver of a substance which is, at least, a principal factor in the important effect of liver extracts on pernicious anæmia.

Working in France during the War of 1914–18, Dakin introduced the use of a buffered hypochlorite solution for irrigating infected wounds. Later, on a ship bringing the sick and wounded from Gallipoli, he made a similar solution by direct electrolysis of sea-water. Another war is reviving the use of such preparations to meet the same and other needs.

Though Dakin has worked in a private laboratory, with but rare collaboration and no pupils, his work has exercised a wide and powerful influence on the growth of biochemistry and on the strengthening of its links with organic chemistry.

Hughes Medal

The Hughes Medal has been awarded to Prof. Nevill Francis Mott.

Early in his career Mott's work in the field of atomic collisions attracted widespread attention. He was the first to show that Rutherford's scattering law holds in quantum mechanics, and to give an accurate theory of the effect of symmetry in scattering problems. When he took up his present post as professor of theoretical physics in the University of Bristol, he abandoned this subject for that of the theory of metals and alloys. Within a few years he was recognized as one of the leading international authorities in this field, to which he contributed a number of important papers on electronic bands in metals and on the electrical conductivity of alloys and its temperature coefficient. In establishing a close association between theoretical and experimental workers he has no superior. He also contributed to the important problem of metals under strain; under his direction Fuchs has calculated the elastic constants of certain metals and obtained good agreement with known values.

Later Mott turned to semi-conductors and insulators, throwing light on the physical processes involved in the formation of oxide films, and in the electrical conductivity which can be induced by various means in polar crystals. His theory (with Gurney) of the formation of the latent image in a photographic emulsion has found general acceptance, and has stimulated fresh experimental work in research departments of the industry.

This striking record of published work was achieved between 1928 and 1939.

When war broke out Mott found that his activities as a quantum physicist had no direct application to the War. It is a tribute to his versatility and flexibility of mind that he could turn so quickly to a new field in classical physics, and make important contributions to the practical problem in connexion with which he now holds an important post.

ABORIGINAL AUSTRALIAN STRING FIGURES

AS time goes on, more and more attention is given to primitive man in his physical, mental and cultural aspects, and among the last-named may be classed that singularly fascinating and complicated pursuit known to us as string figures. It is now nearly forty years since the first collection of string figures was made and described from Torres Straits by Rivers and Haddon, and since then there has been a steady interest in the subject and a mounting number of collections made in different parts of the world. The latest is embodied in an article by D. S. Davidson (*Proc. Amer. Phil. Soc.*, 84, No. 6; Aug. 1941) in which he sums up our present knowledge of the subject and adds a most interesting collection made by him from the Australian aborigines.

That a goodly store was to be collected there was evident from Roth's illustrations of numerous Queensland figures, unfortunately without directions for their making, published in 1902; from some collected by myself from a few restricted areas in 1914, and from Stanley's collections, again from north Queensland, in 1926. Mr. Davidson's studies form a much-needed addition to our knowledge of the subject and are the more valuable in that he traces the possible connexions of these Australian figures with those occurring in other parts of Oceania. According to his conclusions, string figures are of comparatively recent introduction into Australia from Melanesia, as they are found in greatest numbers in north-west Queensland, whereas in Western Australia they are almost lacking and what exist are of recent introduction.

Mr. Davidson considers that Australia, Melanesia, Micronesia and Polynesia comprise a major string-figure area, and from the evidence of the string figures themselves suggests the possibility that they were brought into the Pacific by the Polynesians or Micronesians, and spread from the west into New Guinea and western Melanesia late in the pre-Polynesian period. He suggests also that the diffusion of string figures into the New World and Africa from some Asiatic point of origin might have taken several thousands of years, but he does not appear to consider their possible spontaneous generation in unrelated areas. This is known to have occurred recently among the Brahmins in India and seems likely to be an explanation of their world-wide distribution, seeing that string—or its equivalent—is co-existent with man.

Mr. Davidson has described and illustrated some seventy string figures and in addition gives a comparative chart of their distribution; there is also a bibliography. If one might venture a criticism of one of his descriptions, taking a loop off a digit would seem to indicate removing it, whereas in "Movement Z" it means making the loop common to right and left thumbs. But this is a detail and in no way impairs the interest and value of the contribution.

K. RISHBETH.

THE MOA IN NEW ZEALAND

A RECENT valuable contribution to the natural history of New Zealand by Dr. G. Archey dealing with the moa* fully maintains the high reputation of the ornithologists of that country, and both the author and the Council of the Auckland Institute, who sponsored the work, merit our congratulations.

Almost from its inception the study of the moas has been accompanied by considerable confusion and uncertainty owing to the insufficient definition of types, and to the frequently erroneous association of different parts of the skeleton, an unsatisfactory state of affairs which Dr. Archey determined to remedy. After much patient work involving the examination of types and other specimens both in New Zealand and in England he has produced this excellent monograph of the moas.

Perhaps the most urgent need was for a knowledge of the associated skeleton in the various forms, and in accumulating material for this the author tells how greatly he was helped by many enthusiastic field workers who, since 1930, have discovered and collected in different parts of the North and South Islands no less than fifty fairly complete skeletons, and more than a hundred partial sets of bones of individual birds. Among the facts revealed by this mass of authentic associated material is the hitherto unsuspected occurrence of parallelism in one division of the moas. The author writes ". . . that two subfamilies with widely differing skulls, sterna and phalanges have independently embarked upon identical courses of development of shorter and heavier

* The Moa: a Study of the Dinornithiformes. By Gilbert Archey. Bulletin of the Auckland Institute and Museum, No. 1. Pp. 119+15 plates+9 tables of Measurements. (Auckland: Auckland Institute and Museum, 1941.)

leg-bones" (p. 8). Good evidence is supplied in support of the claim that from the characters of both skull and skeleton the moas can be separated into two natural divisions: "the tall Dinornithidæ, with flattened broad skulls and the normal number of phalanges, are regarded as standing apart from the others." The second division absorbs the remainder, which thus includes a considerable number of genera and species. These two sections are the equivalent of Dr. Oliver's Dinornithidæ and Anomalopterygidæ. Careful diagnoses and descriptions are given of the genera and species, and these greatly help to bring order into this rather unwieldy group. In habits these birds appear to have been tolerant of different climatic conditions, vegetarian in their diet, and dwellers in open scrub and grassland. Dr. Archey refuses to credit the great Dinornis with a maximum height of twelve feet, and thinks that it cannot have exceeded a normal walking height of ten feet. The phylogeny of the moas is of paramount interest, being related to the problem of the origin of all the large flightless birds, but the author does little more than review this subject, although he seems inclined to cling to the belief in a loss of flight through degeneracy. Dr. Percy Lowe's brilliant anatomical researches, coupled with the discovery of an ever-increasing number of large fossil flightless birds in nearly every region of the globe, forces this old belief to appear in a somewhat fantastic light.

The last section of the book, entitled "Development and Extinction", includes much diverse information. The author concludes that the evidence all points to the "final extermination of the Moa by the earliest Polynesian immigrants a considerable time ago, first in the North Island and later in the South, and probably before the arrival of the immediate ancestors of the present Maori tribes in the Fleet migration of 600 years ago" (p. 97). There are also new and interesting details about the occurrence of the remains, notes on recent geological happenings affecting the moas, and so forth. The volume is completed with a comprehensive bibliography, a series of tables of measurements of limb bones, and fifteen plates. This brief notice should serve to show that this is a volume which will be indispensable to every serious ornithologist. D. M. A. BATE.

FORTHCOMING EVENTS

[*Meeting marked with an asterisk is open to the public.*]

SATURDAY, DECEMBER 6

INSTITUTE OF PHYSICS (LONDON AND HOME COUNTIES' BRANCH) (at the South-West Essex Technical College, Forest Road, Walthamstow, London, E.17), at 2.30 p.m.—Dr. W. G. Wearmouth: "Physical Problems in the Plastics Industry".

MONDAY, DECEMBER 8

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 3 p.m.—Lieut. L. G. Trorey: "Photographic Survey by High Obliques; the Canadian Plotter and Crone's Graphical Solution".

TUESDAY, DECEMBER 9

CHADWICK PUBLIC LECTURE (at the Royal Society of Tropical Medicine and Hygiene, 26 Portland Place, London, W.1), at 2.30 p.m.—Mrs. Blaise Gillie: "Post-War Housing in the Light of War-Time Experience".*

ILLUMINATING ENGINEERING SOCIETY (at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 2.30 p.m.—Mr. R. Maxted: "Infra-Red Radiation and Equipment, their Application to Industrial Processes".

INSTITUTION OF MECHANICAL ENGINEERS (Joint Meeting with the Institutions of Civil and Electrical Engineers) (at Central Hall, Westminster, London, S.W.1), at 10.45 a.m.—Conference on "Air Raid Precautions and the Engineering Industry".

ROYAL INSTITUTION OF GREAT BRITAIN (at 21 Albemarle Street, London, W.1), at 2.30 p.m.—Prof. J. C. Drummond: "Recent Advances in the Science of Nutrition and their Significance in War-Time".

WEDNESDAY, DECEMBER 10

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Miss Elizabeth Denby: "The Post-War Home—Its Interior and Equipment". 2: "Using Space to Advantage".

PHYSICAL SOCIETY (COLOUR GROUP) (at the Electric Lamp Manufacturers' Association, 2 Savoy Hill, London, W.C.2), at 2.35 p.m.—Dr. F. H. G. Pitt: "Colour Blindness and its Importance in Industry".

THURSDAY, DECEMBER 11

PHARMACEUTICAL SOCIETY (at 17 Bloomsbury Square, London, W.C.1), at 2.30 p.m.—Mr. Thomas Tickle: "The Influence of Analytical Chemistry on Pharmacy" (Harrison Memorial Lecture).

FRIDAY, DECEMBER 12

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at the Mining Institute, Newcastle-upon-Tyne), at 6 p.m.—Dr. A. Caress: "Plastics and Engineering".

APPOINTMENTS VACANT

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

PROFESSOR OF AGRICULTURE—The Principal, University College of Wales, Aberystwyth (January 15).

JUNIOR ASSISTANT DRAINAGE AND IRRIGATION ENGINEER by the Government of Sierra Leone—The Ministry of Labour and National Service, Central Register Branch, Queen Anne's Chambers, Tothill Street, London, S.W.1 (quoting E.339).

FIRST ASSISTANT PORT ENGINEER for the Basrah Port Directorate, Government of Iraq—The Ministry of Labour and National Service, Central Register Branch, Queen Anne's Chambers, Tothill Street, London, S.W.1 (quoting E.340).

SECOND ASSISTANT PORT ENGINEER for the Basrah Port Directorate, Government of Iraq—The Ministry of Labour and National Service, Central Register Branch, Queen Anne's Chambers, Tothill Street, London, S.W.1 (quoting E.341).

SENIOR ASSISTANT DRAINAGE AND IRRIGATION ENGINEER by the Government of Sierra Leone—The Ministry of Labour and National Service, Central Register Branch, Queen Anne's Chambers, Tothill Street, London, S.W.1 (quoting E.345).

ASSISTANT ENGINEER (CIVIL) for the Gold Coast Government Railway—The Ministry of Labour and National Service, Central Register Branch, Queen Anne's Chambers, Tothill Street, London, S.W.1 (quoting E.346).

REPORTS AND OTHER PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

Interim Scheme for the Training and Resettlement of Disabled Persons. Pp. 8. (London: Ministry of Labour and National Service.) [411

University of London: University College. Calendar, Session 1941–1942. Pp. lxiv+228+lxv–lxxviii. (London: Taylor and Francis, Ltd.) [1111

Other Countries

Brooklyn Botanic Garden Record. Vol. 30, No. 4: Prospectus of Courses, Lectures and other Educational Advantages offered to Members and to the General Public, 1941–1942. Pp. vi+225–251. (Brooklyn, N.Y.: Brooklyn Institute of Arts and Sciences.) [311

Trinidad and Tobago: Forest Department. Administration Report of the Conservator of Forests for the Year 1940. Pp. 6. (Trinidad: Government Printer.) 6*d*. [311

Government of Travancore. Administration Report of the Government Museum, 1115 M.E. Pp. ii+8. (Trivandrum: Government Press.) [311

Smithsonian Miscellaneous Collections. Vol. 101, No. 4: Diseases and Artifacts on Skulls and Bones from Kodiak Island. By Aleš Hrdlička. (Publication 3640.) Pp. ii+14+11 plates. (Washington, D.C.: Smithsonian Institution.) [1011

Gold Coast Colony. Report on the Forest Department for the Year 1940–41. Pp. 6. (Accra: Government Printing Department; London: Crown Agents for the Colonies.) 1*s*. [1011

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