NATURE

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Modern Witchcraft.

THE symposium on spiritualism which, as already noted in NATURE, the *Daily News* has been publishing, is of some importance even though it be merely an indication of the deplorable and sometimes almost pathetic attitude of prominent laymen towards the scientific method of approaching obscure problems. From the great majority of the articles submitted, it would seem that not only are the methods of science wholly misunderstood, but also that there is little appreciation of the meaning of evidence when applied to physical and psychological matters. This is the more surprising when we remember that prominent legal writers have contributed to the series, and aptly illustrates the fact that the human mind finds it difficult to apply the same standards of evidence to subjects which differ both in their general content and above all in their emotional significance.

The terms of reference under which the symposium was conducted were grouped under three heads. First came the question of deciding if the claims of spirit communications made by spiritualists are proved or disproved, or indeed if they can be proved or disproved. Secondly, the evidence or experience on which the writers' opinions were based was requested; and finally, a reply was sought to the question whether the growth of spiritualistic practices was likely to prove a menace or otherwise to mind or body. Apart from the confusion between 'spirit communications' and 'spiritualistic practices,' the terms are simple and, whilst not well adapted for scientific discussion, are broad enough for popular opinion. Moreover, the elasticity of the terms might have given the writers good excuse to present some of the evidence in detail, which would have been of interest to the general reader.

From this point of view, however, the symposium cannot be called a success. It must be clearly remembered that the scientific method is the only one properly applicable to these alleged supernormal phenomena. Theories based upon theological or philosophical speculation have little real value until the facts which underlie them are found to be so far related to the known that they can be properly described, and the phenomena concerned repeated at will, or at least adequately and repeatedly observed. Until this is done the alleged facts are themselves suspect. The believers in early witchcraft would have provided better evidence for their faith than that which the exponents of the modern variety have contributed to

this symposium. Statements are made and stories related without any sound evidence being adduced in their support. Similarly, the opponents of the spiritualists have to a great extent contented themselves with arguments which leave untouched the kernel of the problem. We are not concerned, for example, with whether alleged spirit communications are trivial or profound, sublime or ridiculous. To assert that, because in so many cases they are trivial and ridiculous, *therefore* they cannot proceed from spirits, is to assert that we have knowledge as to what spirit communications *ought* to be like, and no such knowledge exists. Again, when it is asserted that certain of the phenomena are explained by 'telepathy,' the statement has no meaning. Telepathy does not explain anything. It is merely a name invented to describe a supposed process concerning which we know nothing, not even that it exists.

Attempts have been made repeatedly to demonstrate experimentally the existence of telepathy. Probably the best known trials were those undertaken with Prof. Gilbert Murray acting as percipient. One might have supposed that, with so distinguished a collaborator, experiments would have been devised which would have had at least some relation to ordinary scientific procedure. Such, however, was not the case. The tests partook much more of the nature of parlour games, and we understand that suggestions for further and properly controlled experiments have been rejected. The same story echoes down the ages. The writers of the *Daily News* symposium have little to add to the questions of Porphyry and the answers of Iamblichus; the stories of St. Augustine and the caustic satire of Lucian. The problem was the same then as now. The excuses and subtle methods of the medium Alexander of Abonutichus were identical with those used to-day in the séance rooms of West London. In the circumstances, it is difficult to be surprised at the general attitude of modern scientific men who are apt to regard the witchcraft of to-day in the same light as they regard the witchcraft of yesterday, as a belief based upon fraud, delusion, and hypocrisy.

Now, whatever may be the truth underlying alleged supernormal phenomena, there is no doubt that an increasingly large number of persons believe in their reality. Even if such phenomena have never occurred, it is indubitable that human beings of all ages and times have reported them in terms of such remarkable similarity that it is difficult to believe that similar sets of circumstances have not originated them. For example, the stories of haunting phenomena have been so similar for hundreds of years that we cannot doubt that certain events do take place in certain houses which lead the occupiers to describe their experiences in the same way and to maintain that they are inexplicable. Now, apart from the question of the normal or supernormal character of the phenomena of haunting, these facts alone are worthy of the attention of science. What are precisely the circumstances which lead people in ordinary life to describe in detail the appearance of phantoms which are not rarely seen by more than one person at the same time? What are the conditions which lead persons widely separated in time and space to describe the appearance of showers of stones which seem to fall out of the air (the so-called stone-throwing poltergeist)? Again, how can we describe adequately those abnormal psychological mechanisms which result in cases of multiple personality, where certain of the so-called secondary personalities betray knowledge of persons and events which careful inquiry fails to prove could at any time have been within the normal content of the subject's mind? Precisely the same problem is presented regarding the beliefs of primitive peoples. Phenomena, inexplicable to the natives themselves, and also to European observers, have been reported from all parts of the world.

The *Daily News* symposium is some slight indication of how superstition and credulity are fostered on account of our ignorance of the origin and basis of these world-wide tales. We cannot doubt that a more complete and systematic investigation is desirable, but at the same time it would seem that it is not the duty of the ordinary scientific man to undertake researches in this field. The first necessity is a thorough knowledge of the art of mystification, and this implies a good acquaintance with those psychological factors underlying conscious and subconscious deception, pathological lying, false memory, number preferences, and similar conditions. The ordinary physicist does not possess any of these qualifications, and the results of lacking them can be observed if we study the amazing history of the *N*-rays to which Mr. Campbell Swinton alluded in his article in the *Daily News*.

The subject is at present outside the range of competent scientific inquiry, and thereby a mass of valuable information is being lost. Whatever may be the explanation of the belief in supernormal phenomena, we can scarcely deny that it has had an enormous effect upon the happiness and misery of mankind. Belief in these occurrences appears to

be increasing, and the only method of checking its progress or confirming its basis is the application of impartial, unemotional, and rigid scrutiny of the alleged facts by men trained to detect sources of error and possessing some knowledge of the history of the problem in its relation to human thought. Such inquiry, we think, cannot be much longer delayed. The symposium we have been considering is a fair indication of the chaos in the mind of the public, and the recent prosecution of a 'medium' by the State shows the same uncertainty and hesitation in the mind of the Government. An inquiry conducted on scientific lines would be a task of great magnitude and considerable difficulty. On the other hand, if the only result were to fail to find any evidence of 'supernormal' activity, a very important body of material would have been collected which must throw a good deal of light on the psychological questions involved in mal-observation and error, not only in civilised peoples but also among the inhabitants of countries which have not at present wholly absorbed the culture of the West.

The Making of an Epoch.

The Discovery of the Rare Gases. By Prof. Morris W. Travers. Pp. vii + 128. (London: Edward Arnold and Co., 1928.) 15*s*. net.

THE discovery of a new chemical element is a feat of a kind that is unique, and in one aspect it may be said to be above all other discoveries. For the worker who finds a new natural law of *action*, however great it may be, must temper his pride with the reflection that inevitably his law will in time be shown forth as but a part of some still greater one, incorporating his own: "After me cometh a builder. Tell him, I too have known." But the existence of an element is a fact of the universe; an element is a cosmic unit, superior to the accidents of place and time; it will outlast man who discovered it for himself; ironically enough for the chemist who finds it, it can even outlast chemistry and all that works by chemistry in Nature. It is this which justifies us in hailing Priestley and Scheele, Berzelius, Davy, Mosander, Bunsen, Rayleigh, Ramsay and Travers—and let us add Mme. Curie, Hevesy and Coster—together with the two score or so successful followers of their methods, as being privileged far beyond the ordinary; so also, of course, the discoverers of the electron and of the proton. To tell the full tale of any one of these investigators' work worthily, and while first-hand recollection is still there to be drawn upon, is to give us, and to leave to our scientific posterity, something to be grateful for.

What it is in Ramsay's discoveries which makes them conspicuous among the greatest work of this kind, needs little explanation now, when thirty years have given time for even those who were at first backward or hastily critical to be taught. Let those who have watched the unrolling of the scroll since 1893 pause to recall how they were first astounded by Rayleigh and Ramsay's finding something new in air—in air!—then by its being an element—an inert, monatomic element!—then by Ramsay's suddenly producing a quite new gaseous surprise out of quite another magical hat, the materialisation of a spectral line scarcely anyone had seen; and how then there came the period of suspense, while the chemical world talked or waited or went about its business, and Ramsay, and Travers with him, strove to push on into the new country that they believed in—and suddenly got there, with krypton, neon, and xenon. A whole unsuspected group! No other chemist has done it. Thereafter a well-earned increment to the group came with Rutherford's radium emanation; the weighing of emanation by Ramsay and Whytlaw Gray, the discovery by Ramsay and Soddy of the formation of helium from it, with Rutherford's precise identification of his α-rays with helium particles, all these rounded off one astonishing chapter and began another. Now, in this later chapter—would that Ramsay could have lived to see it—the newer generation of chemists and physicists familiarly use Ramsay's elements as fixed and indispensable bench-marks in the atomic surveying whereby Mendeléeff's atomic geography is seen to fall into one consistent frame; and factories bottle the gases in cylinders. Seen thus, the whole thing has only one parallel, and that is Priestley's discovery of oxygen, and its after-math. The parallelism can be traced out quite closely; and the debt of the twentieth century to Ramsay in physical science is proving not less than that of the nineteenth to Priestley.

Accounts of the work on the inert gases have been issued before, as for example by Rayleigh as regards argon ("Scientific Papers," vol. 4, 188-201), and in his son's "Life of Lord Rayleigh"; by Ramsay ("Gases of the Atmosphere," 3rd edit., 148-269), and by Tilden in his "Life" of Ramsay (1918). For this reason it is natural that some of what Dr. Travers tells in the present volume is broadly familiar; but there is much that will be new, and greatly welcome, to its readers. For a story of classical discoveries cannot ever be told

to our full satisfaction by their originator, because he either does not realise or else cannot in modesty tell his own traits and behaviour in action, upon which his success so largely depends; and the trivial, yet to us interesting, personal incidents of the work are to him irrelevant. Even his familiar letters miss out much that we can only guess at; whilst a later biographer, however sympathetic, can rarely be as circumstantial as we should like; of strategy we read little, of tactics a good deal, and of behaviour under fire only rarely. Here, however, is an account at first hand from one who was a brilliant and essential junior partner in all but the very first part of Ramsay's work on the rare gases; and it is based upon Ramsay's own MS. papers and laboratory notes, handed over to Dr. Travers by Lady Ramsay and Mrs. Tidy with an invitation to arrange them. Dr. Travers has brought all his own enthusiasm to renew that which created his material. Consequently, the spirit of the account as a whole, and the numerous circumstances that are recaptured, reveal to the reader more vividly than any other written word the indomitable artillery of Ramsay's opening attack on a problem, and the flashing élan with which he launched his full force into the breach to carry the citadel.

The genesis of Lord Rayleigh's fundamental work on gaseous densities, out of which came his own and Ramsay's discovery of argon, lay in his plan, formed in 1882, to test Prout's hypothesis. Dr. Travers dwells instructively and at length upon this point, which has also been mentioned by Ramsay himself (loc. cit.) and by Tilden in his "Life." (It is curious that both for Cavendish and for Rayleigh it was the same element—nitrogen—which began by being a nuisance and was in each case turned, under masterly hands, into a source of rich knowledge.) Dr. Travers, in treating of the ensuing joint researches (four chapters are devoted to argon), says:

"Lord Rayleigh and Ramsay stand out from amongst their contemporaries, chemists and physicists, as the two men who alone realised the significance of the apparent discrepancy in the densities of nitrogen. They were also the two men who alone were capable of developing the discovery. In genius, method, and temperament each was in many respects the opposite and the complement of the other. No modern discovery ever awakened more interest than the discovery of argon; never did scientific men receive more gratuitous advice or criticism; but never was advice or criticism more completely sterile."

Ramsay, on his part, brought to the problem, besides his own qualities, a technique in glass-blowing and in the handling of gases which all his Bristol and London work had fostered (and at that time there were very few glass-blowing chemists); and he brought a repertoire which included an unsurpassed wealth of chemical fact and a great deal of quite recent physics. For example, he tried magnesium as the absorbent for nitrogen because, as he tells us (loc. cit., 158), he had noticed its property several years before while trying to synthesise ammonia in the presence of various heated metals. The property was not at all common knowledge among chemists. Again, the idea that the ratio of the specific heats of a gas gives a clue to its molecular complexity must have been little known to the average chemist, and Dr. Travers shows how it was doubted by many physicists; yet Ramsay was not merely aware of the idea, but had actually applied it experimentally in studying some organic compounds; so he was able at once to turn to it—the only possible test—to try the complexity of the argon molecule. As Lord Rayleigh pointed out, it was only when that had been done that they allowed themselves to utter a word suggesting that argon was an element.

Arising out of the last-mentioned measurements, Dr. Travers tells us that Ramsay did the whole of them, including controls, between Monday morning and Friday evening; and he adds the significant remark: "That work carried out in this manner could be so highly productive was due to Ramsay's insight into the essentials of a chemical problem, and his judgement as to the degree of experimental accuracy required in order to furnish adequate proof of the particular hypothesis which he was investigating." With this we may link another quotation given from Rayleigh and Ramsay's Royal Society paper: "Although the evidence of the existence of argon in the atmosphere . . . appeared overwhelming, we have thought it undesirable to shrink from any labour that would tend to complete its verification." These principles permeate the whole subject of Dr. Travers's book.

As all who have been privileged to be with Ramsay know—and let me add, what Dr. Travers could not, that the following remark applies to him also—the speed with which he arranged experiments and made them go was extraordinary. From the start of his share of the work leading to argon, it took him a month to obtain "the gas which I think I have got" (written to Rayleigh); and about another month to isolate it in bulk and

find its density (August 1894). For speed, however, the discovery of helium in March 1895 would be hard to match; for it took a fortnight. Was ever 3*s*. 6*d*. better spent? Incidentally, we are reminded by Ramsay's MS. notes (here generously reproduced in facsimile) that helium was provisionally christened "krypton" until Crookes's telegram came: "Crypton is helium 58749. Come and see it."—"Went and saw it," is Ramsay's laconic addition to his MS. copy. This chapter (v.) will be found very interesting.

The ensuing three years are covered in as many chapters, and with Chap. ix. (May and June 1898), where Dr. Travers's own memories of all the comings and goings are at their keenest, we reach the best of the twelve in the book. Ramsay and Travers's irresistible pinning-down of krypton and xenon at their very first handling of liquid air, and the unforgettable moment when neon blazed into their ken, are made the culminating point of a dramatic and yet matter-of-fact story, the end of which is rightly drawn at the close of Travers's work with Ramsay.

The frontispiece, diagrams, and the ample facsimiles of MSS. are happily chosen and are well reproduced. By some strange oversight, nearly all the dates in the text are wrong, but as the error is either one decade or two, it jerks us into the wrong century and the intention is obvious. A few other slips in writing (for example, p. 67) will doubtless be put right for later issues. The format and type work are dignified, as the book deserves.

All who worked with Ramsay, very many who did not, and every young student of chemistry or of physics, should read this book; they will gain great pleasure and new inspiration. For, as Dr. Travers writes of Ramsay, and finely exhibits in this volume, "He was a great friend, a great leader, and a great man." IRVINE MASSON.

Timber Exploitation.

Manual of Forest Engineering and Extraction. By J. F. Stewart. Pp. xv + 188 + 100 plates. (London: Chapman and Hall, Ltd., 1927.) 15*s*. net.

MR. STEWART'S book has been written primarily for forest students, but it should also be useful to those engaged in timber exploitation in many parts of the world. The subject dealt with is a very wide one, covering as it does the preparation of streams for floating, river surveys, the felling and clearing of areas, logging operations, including the construction and use of wire ropeways, slides, chutes, inclined tramways, the construction of forest roads and bridging, the building of all classes of forest rest houses, sawmills, and finally extraction work in Indian forests. It would be possible to write a volume on any one of these subjects, and therefore the author has had of necessity to deal with each subject somewhat briefly. His personal experience of forest engineering in many parts of the world, and especially in Canada and Africa, has enabled him to bring out clearly the important points requiring special attention by young forest engineers confronted with the everyday problems they have to solve, in those forests of the Empire which at present are not under intensive working. Much sound advice is given on camping in unhealthy forests, on the choice of camping grounds, and precautions necessary when camping in both temperate and tropical climates. A small omission is made when dealing with methods of transport in India, as no mention is made of the bullock-cart, while the elephant is omitted as a drag-animal in the chapter dealing with felling and clearing forests, though mentioned in the last chapter.

Surveying, clearing streams, and log transport is briefly dealt with, though the reader may feel the need of diagrams to enable him to picture clearly in his mind the different types of skids and sledges in use. Wire ropeways are dealt with in some detail, and necessarily so, as they form an important means of exploiting logs in such areas where extensive concentrated fellings are undertaken, as is the case in Canada and the United States of America.

The chapters dealing with slides, chutes, inclined tramways, roads, and trestle bridges are perhaps the most instructive and useful. The types of each class are dealt with lucidly and clearly, the subject matter being sufficiently well illustrated by photographs and diagrams to enable a forest engineer to select and construct the type most suited to the individual extraction problem before him. Considerable space is given to forest railways and water transport, based chiefly on work in Canadian and North American forests; the value of these chapters, and especially that on floating, would have been enhanced by descriptions and illustrations of similar work in other parts of the world. "Permanent Buildings" is perhaps not a quite correct heading for Chapter xi., which also deals extensively with grass huts and similar temporary erections as used in central Africa; this in no way detracts from the value of the subject matter. The work ends with a brief chapter on forest operations

in India. The author describes camping as luxurious, which is undoubtedly the case in certain provinces, but very much the reverse in others.

The subject as dealt with clearly denotes Mr. Stewart's wide practical experience, as the information that matters when having to carry out work of this character in the forest is dealt with in such a manner as will assist the young engineer; this being so, it is the information necessary to impart to the student. The illustrations are profuse and good, making with the subject matter a valuable addition to the literature on forest engineering and extraction.

Modern Physics.

Introduction to Modern Physics. By Prof. F. K. Richtmyer. Pp. xv + 596. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1928.) 25*s.* net.

THERE is a distinct tendency in recent American text-books for the authors to expound the subject matter of physics as if their books were intended to appeal to readers whose professional interests are not very closely allied to their progress in physics. Prof. Richtmyer's book may show some traces of this tendency, but it is undoubtedly intended for readers who are keenly interested in modern physics, although his delightfully clear introduction to the subject will certainly introduce him to a very wide circle of readers. In fact, his book is one of the most valuable of the contributions to the literature of physics which American writers have made.

Although the work is termed an introduction to modern physics, it is more strictly speaking an introduction to modern physical theories, and the author has selected for examination some of the more important classical concepts as well as the modern concepts of physics, in order to give his readers a correct perspective of the growth and the more recent development of the subject as a whole. He has consequently omitted a description of certain important branches of modern physics, such as thermionic phenomena, from his work, and has only briefly mentioned certain other important branches, such as the conduction of electricity through gases. Yet his very sound and thorough exposition of the chosen branches is undoubtedly of much greater value to us than any skeleton key or guide to the study of modern physics could possibly be, and he is able to achieve the desired object of outlining the origin, development, and present state of those two mighty, outstanding problems of modern physics, the reconciliation of the quantum and wave theories of light and the structure of matter. It is, however, a matter of regret that he has not taken the opportunity to present us with a simple outline of the conceptions recently introduced by wave mechanics.

Prof. Richtmyer opens with a historical sketch, dividing the history of physics into four periods, namely, the period from earliest times to A.D. 1550, in which experiment was absent; the period from A.D. 1550 to 1800, in which experimental methods of scientific inquiry were established; the period A.D. 1800 to 1890, in which those portions of physics which we term classical physics were developed; and lastly, the period dating from the discovery of the photoelectric effect in 1887 to the present day. There is nothing particularly exciting or original about this historical sketch; it is merely a very useful form of introduction which finds a definite place in a book of this type. The author then devotes a chapter to the electromagnetic theory of light, in which Maxwell's equations are developed, and it is shown that the theory requires that an accelerated electric charge should always radiate energy, the wave front being continuous. Then follows a chapter on the theorems concerning the radiation from moving charges. The fifth chapter deals with the photoelectric effect, and is noteworthy for the clear way in which the possible explanations of the effect are discussed, the author indicating the difficulties confronting the wave theory and pointing out that, all the same, we have to rely on the wave theory to give us the energy value of a quantum.

The study of black body radiation and the origin of the quantum theory is excellently outlined in the sixth chapter, which is followed by a discussion of the quantum theory of specific heats, wherein Debye's theory is described at length and the reader referred to other works for the theories of Born and Kármán, etc. Incidentally, detailed references to special treatises and original papers are lavishly distributed in footnotes throughout the book. The ninth chapter, on series in line spectra, forms a very satisfactory introduction to the subject. The notation given by Fowler is used for the purposes of this preliminary discussion; but in the following chapter, on the nuclear atom and the origin of spectral lines, the notation of Russell and Saunders is adopted to deal with inner quantum numbers. These two chapters are likely to be much appreciated by students.

Some attention is devoted to the consideration of the static atom in the eleventh chapter, preceding a

discussion of the problem of the distribution of electrons in atomic orbits and the spectroscopic method of solution of the problem. The twelfth chapter is a very fine and up-to-date survey of our knowledge concerning X-rays. Finally, in the last chapter the problems of the nucleus are briefly reviewed, and here, in order to appreciate the care with which the book has been written, the reader may be recommended to consider the simple diagram of the magnetic deflection of α-, β-, and γ-rays and to compare it with the diagrams given in other text-books. Among the appendices is a table showing the distribution of electrons in atomic orbits, according to Foote, and a table of important physical constants, and an efficient index is provided.

The book is excellently printed and illustrated, and Prof. Richtmyer is to be congratulated upon the appearance of a useful work which may be confidently recommended to teacher and student alike. L. F. B.

British Myrmecophilous Insects.

The Guests of British Ants: their Habits and Life-Histories. By H. St. J. K. Donisthorpe. Pp. xxiii + 244 + 16 plates. (London: George Routledge and Sons, Ltd., 1927.) 18*s*. net.

ONE of the most interesting and remarkable features of the biology of social insects is betrayed in the relationships they maintain with other animals living in association with them. A very large number of the latter creatures are myrmecophiles or ant guests and the majority of them are insects. Although British ants number only 35 species, many times that number of myrmecophiles are known to live in a more or less definite biological relationship with them. In some cases they are extranidal, or in other words, the ants seek out their myrmecophiles, while in others they are intranidal, the ants being passive and are sought out by their guests. Mr. Donisthorpe's enthusiasm and energy have enabled him to add 146 species to the myrmecophilous fauna of Great Britain, of which no less than 70 were new to science at the time of their discovery. His intimate knowledge of this subject has enabled him to produce a book that will long remain a standard work.

The volume is arranged so that each order or group of myrmecophiles is dealt with in a chapter of its own. The Coleoptera are by far the most numerous in point of species and, since they are a favourite order with the author, are discussed at length. Five British species are true guests or symphiles, which are tended and often fed and licked by their ant hosts. The largest number, however, are synoeketes or forms which are indifferently tolerated within the nest: they are represented by members of nine families of beetles, the majority being Staphylinidæ. A small number of species of the latter family are synechthrans, which are hostile in behaviour, forcing themselves on their hosts and usually devouring them or their offspring.

In the chapter on Hymenoptera the relations which ants exhibit with members of their own or of different species are discussed, while the various kinds of Parasitica found within the confines of the nests are enumerated. We know less concerning these than almost any other group of myrmecophiles: some are unquestionably parasitic upon ants, a larger number probably parasitise various other myrmecophiles, but with regard to the majority, little beyond conjectural remarks can be made, and they offer a promising field for exploration by a skilled observer.

In the short but interesting chapter on Lepidoptera, five species of moths are regarded as synoeketes which live within the nest in the rôle of scavengers. The relations between ants and certain Lycænid caterpillars are largely extranidal, the ants seeking out such larvæ wherever they are feeding in order to imbibe their glandular secretions. In the case of *Lycæna arion*, the larva, when in its fourth instar, is carried by ants into the nest, notwithstanding the fact that it lives at the expense of their own larvæ. Other chapters are concerned with Diptera, Hemiptera (three chapters), Acarina, Isopoda, etc., and the book concludes with a bibliography and both authors and species indexes. A. D. IMMS.

Our Bookshelf.

(1) *Comparative Physiology of the Heart.* By Prof. A. J. Clark. (Cambridge Comparative Physiology Series.) Pp. vi + 157. 8*s*. 6*d*. net.

(2) *The Comparative Physiology of Internal Secretion.* By Prof. Lancelot T. Hogben. (Cambridge Comparative Physiology Series.) Pp. vii + 148. 10*s*. 6*d*. net.

(3) *Ciliary Movement.* By J. Gray. (Cambridge Comparative Physiology Series.) Pp. viii + 162. 10*s*. 6*d*. net.

(Cambridge: At the University Press, 1927 and 1928.)

HUMAN physiology will ever continue to be the science which will pre-eminently fascinate the mind of man in virtue of the directness and personal character of its appeal. The versatility of man, which has placed less resourceful creatures under his dominion, has also led to the combination of so many physiological processes in a single species that it is not surprising that several of these processes,

considered individually, may be found more highly developed in lower species. For the better understanding and for the more thorough investigation of such living processes, recourse must be had to animals in which the particular mechanism under consideration is most highly typified. It is just here that the Cambridge series of Monographs on Comparative Physiology brings the student or worker in physiology into touch with the evolution, the variety, and what might perhaps be regarded by him as the exaggeration of normal human processes.

(1) The heart is the organ which has always attracted the attention of human beings from the remotest ages, and it is fitting that a volume should be devoted to this organ, giving in this case some qualitative and many quantitative characteristics of species differing widely in their normal activities.

(2) The discovery of internal secretions is so recent and so largely based on a study of the higher vertebrates, that a volume putting forward the present state of knowledge regarding the invertebrates as well is useful not only in making possible wider generalisations, but also in providing new material of a simpler type for further investigation.

(3) The volume on ciliary movement deals with a subject which, in virtue of its complete overshadowing by muscular movement, is only very briefly referred to in text-books on human physiology; its study is best carried out in those organisms depending wholly on ciliary movement for locomotion, muscular movement being non-existent; only in this way can the various hydrodynamical problems be investigated.

All three volumes present the matter in a readable manner with well-chosen diagrams, and will prove of interest to the student of general physiology as well as to the physiological investigator.

(1) *In the Beginning: the Origin of Civilisation.* By Prof. G. Elliot Smith. (The Beginning of Things Series.) Pp. vi + 90. (London: Gerald Howe, Ltd., 1928.) 2*s.* 6*d.* net

(2) *The Origins of Agriculture.* By Harold Peake. (Benn's Sixpenny Library, No. 6.) Pp. 78. (London: Ernest Benn, Ltd., 1928.) 6*d.*

(1) PROF. ELLIOT SMITH'S little book, though not the first in order of publication, is the introductory volume in the series "The Beginning of Things." In his prefatory remarks he explains that the object of the series is the publication of a number of volumes, each dealing with some aspect of culture from a common point of view. What this point of view is, it is the purpose of the introductory volume to demonstrate.

Here we have Prof. Elliot Smith at his best. So far as the theoretical side goes, he has given us no more lucid and logically argued statement of the case for his views on the diffusion of culture and its origin in Egypt. Although he is careful to point out that the pursuit of any single line of investigation such as the origin of agriculture or of metal working leads to disaster, virtually his case rests upon the first cultivation of barley in Egypt.

(2) Mr. Peake, in his brilliant little study of the origin of agriculture, of which the size and the popular form of publication are no criterion of the importance, is directly at odds with Prof. Elliot Smith. He has collected carefully all the evidence bearing upon the origin of the different kinds of grain. After a judicial survey, his conclusion is on the whole against Egypt and turns rather to northern Syria. Apart from this question, Mr. Peake's book gives an admirably reasoned account of the prehistoric conditions of life in which agriculture must have originated.

Where are the Dead? Pp. ix + 136 + xi. (London, Toronto, Melbourne and Sydney: Cassell and Co., Ltd., 1928.) 3*s.* 6*d.* net.

THIS volume comprises a collection of articles by a wide variety of writers upon the subject of human immortality, contributed to the *Daily News*. Undoubtedly the most interesting of these to students of science will be the contributions of Sir Arthur Keith and Prof. Julian Huxley, since these contain a concise and clear statement of views widely held in scientific circles. It is probable that the importance for religion of either positive or negative views on this subject has been exaggerated.

Sir Arthur Keith rightly says that "If the spirit of truth is the kernel of religion, then men of science are truly religious beings." He might have added that absorption in disinterested research is one of the modern spiritual equivalents for religious asceticism. At the same time, students of science should not overlook the significance of a point of view such as that expressed with great ability in the contribution by Mr. Hugh Walpole, which strikes us as in some ways the best thing in the book. Whilst the others, orthodox and unorthodox alike, are all more or less obsessed with the distinction between body and mind (even when they reduce these to common terms), Mr. Walpole sees that the only important distinction is that between the elements in our experience which are exactly measurable, and those which are not. The important thing about man is not that he has, or has not, a 'soul,' but that "out of such a midget there have proceeded the spiritual greatness of Hamlet, the magnificence of the Fifth Symphony, the glorious simplicity of St. Francis. . . ." J. C. H.

Factors affecting the Distribution of Electrolytes, Water, and Gases in the Animal Body: Lectures delivered at Rutgers University under the Luther Laflin Kellogg Foundation. By Dr. Donald D. Van Slyke. (Monographs on Experimental Biology.) Pp. vii + 62. (Philadelphia and London: J. B. Lippincott Co., n.d.) 10*s.* 6*d.* net.

THE title of this little monograph may alarm those who are not gifted with a taste for mathematics, but its perusal leaves only a feeling of admiration for the manner in which the author has presented his subject. An examination of the degree to which the distribution of electrolytes, water, and gases in the body obeys the laws of physics and chemistry necessitates the use of a certain amount of mathematics, but the presentation is so clear

that even the average student should be able to follow it with ease. The subject matter forms a useful exposition of the way in which physico-chemical theory can be applied to the prediction of biological phenomena, as well as the necessity, in considering such phenomena, of using the methods of synthesis in addition to those of analysis, if a true idea of their influence upon each other in the living intact organism is to be attained. Among the subjects dealt with are the functions of hæmoglobin and the mechanisms of the production of œdema. A selected bibliography is appended. For its size, the price seems somewhat high; but the monograph is well worth reading by all interested in this subject.

Aspects actuels de la physiologie du Myocarde. (Première série.) *L'onde d'excitation motrice, son origine, sa propagation, ses manifestations électriques.* Par Prof. Henri Frédéricq. (Les problèmes biologiques, Tome 7.) Pp. viii + 300. (Paris: Les Presses universitaires de France, 1927.) n.p.

THIS is the seventh volume to appear in the collection of monographs on biological problems issued under the guidance of a technical committee comprising some of the best-known names in French biological science. The preceding volumes have, in the main, dealt with physico-chemical and embryological subjects, with the exception of Lapicque's important monograph on a subject which, like the volume under review, is more directly physiological. The author has collected together a considerable amount of data of a representative character and he has moulded it into an orderly review of the present state of knowledge with regard to these properties of the myocardium, while each chapter is rounded off with a useful summary. The book should make an appeal to students of physiology and also to medical practitioners, since the subject matter is concerned chiefly with the mammalian heart.

Macedonian Imperialism and the Hellenization of the East. By Prof. Pierre Jouguet. Translated by M. R. Dobie. (The History of Civilization Series.) Pp. xx + 440 + 7 plates + 4 maps. (London: Kegan Paul, Trench and Co., Ltd.; New York: Alfred Knopf, 1928.) 21*s.* net.

THE keynote of this volume is the imposition of political unity on the "small collective individualities" of which the rise has been described in the earlier volumes of the Greek series, and the demonstration of how the common civilisation, which had hitherto been their bond, was affected by an external force which in its origin at least was alien to Hellenism. The hero of the epic, for it is nothing less, is necessarily Alexander, and of him Prof. Jouguet has made a truly epic figure. He sees in him intensity of character, power of imagination and thought, fortified by literature and philosophy. His qualities were accompanied by an extraordinary clearness of mind in carrying out his projects. The weaknesses of Alexander may lead one to question the true character of his idealism, but of his genius there can be no doubt. To this Prof. Jouguet does full justice, without attempting to disguise the flaws in his organisation, which led to the break-up of the Empire. In dealing with the later period, the author's very careful study of Egyptian conditions especially calls for commendation.

Raw Materials of Commerce. By J. Henry Vanstone, assisted by Specialist Contributors. Complete in about 24 Fortnightly Parts. Part 1. Pp. ii + 32. (London: Sir Isaac Pitman and Sons, Ltd., 1929.) 1*s.* 3*d.* net each part.

THIS work is planned to give accurate and modern information about the raw materials of industry. It is to be divided into four sections, covering vegetable, animal, mineral, and synthetic products respectively. The contents gives the impression of a comprehensive work which should be of considerable value to students of geography, economics, and commerce, as well as to persons actually engaged in manufactures. The first part, in addition to the introduction, has articles on fibres generally, cotton, flax, and jute. Each article describes the plant concerned, conditions of cultivation, harvesting, and the preparation and marketing of the fibre. The author has succeeded in combining accuracy with the avoidance of unduly technical language. Much of the matter is not otherwise readily accessible except in expensive works dealing with one or other industry, or is scattered in technical journals. The work is well illustrated by photographs, maps, and coloured plates.

Principles and Applications of Electro-Chemistry. By Prof. H. Jermain Creighton. Second edition, revised and enlarged. In 2 volumes. Vol. 1: *Principles.* Pp. xvi + 488. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1928.) 20*s.* net.

THE first volume of Creighton and Fink's book on "The Principles and Applications of Electro-chemistry," dealing with principles, has reached a second edition before the second volume, dealing with applications, has appeared. The second edition includes new chapters on "The Activity of Strong Electrolytes" and on "Theories of Strong Electrolytes," but the author has postponed the drastic operation of making the rest of the volume conform to the theory of complete ionisation.

Lehrbuch der physikalischen Chemie. Von Prof. Dr. Karl Jellinek. Fünf Bände. Zweite, vollständig umgearbeitete Auflage. Band 2: *Die Lehre vom festen Aggregatzustand reiner Stoffe; Die Lehre von den verdünnten Lösungen.* Lieferung 5. Pp. 273-560. 24 gold marks. Lieferung 6. Pp. xiv + 559-924. 32 gold marks. Band 2 vollständig. 88 gold marks. (Stuttgart: Ferdinand Enke, 1928.)

THE two sections now received complete the second volume of Prof. Jellinek's text-book, of which the first volume and the initial section of the second volume were recently noticed in these columns (Oct. 6, 1928, p. 523).

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Observations of Luminosity of the Night Sky.

WE have now observed the luminosity of the night sky for three years at the Commonwealth Solar Observatory, using photometers kindly supplied by Lord Rayleigh. These measure the absolute intensities of three regions of the spectrum—the red, a patch of green which includes the auroral line, and the blue.

If it is legitimate to assume that the transmission through the red filter is free from auroral radiation, or at least that the latter is not important compared with the amount of continuous radiation which passes through it, it is possible to devise a method for eliminating all, or at any rate the bulk, of the continuous radiation superimposed upon that which is localised in particular regions of the spectrum. For this purpose it is only necessary to observe the sunlit sky or the moon through the photometer when the incident light has been reduced in strength to the scale of night sky intensities; this must be done in such a way that its quality is unchanged. Corresponding readings are then made of the transmissions through the three filters over the range usually encountered; from these, graphs are drawn relating the green and blue readings with those made through the red filter.

We are thus enabled to find the amount of green radiation associated with the continuous spectrum for any observed red reading; we subtract it from the radiation observed through the green and blue filters, thus obtaining the green and blue transmissions presumably free from the background of white light. By confining our attention to nights free from haze, we hope to avoid trouble from selective scattering at the red and blue ends of the spectrum. For similar reasons we avoid times when the sun or moon is near the horizon. A considerable amount of green auroral radiation remains, and its fluctuations may be traced throughout the year. Maxima tend to occur in April–May and October–November. In 1926 the former, and in 1927 the latter, was the more pronounced. In the present year the April maximum was very marked, but the November readings now in progress are on some nights exceptionally large.

The true auroral blue component fluctuates in a somewhat similar way but with a smaller amplitude. It is probably absent altogether at certain seasons. There is high correlation between the blue and auroral green values about April and November, with low values at other times. Lord Rayleigh's suggested division of auroræ into two types, polar and non-polar, is supported; it is suggested that the occurrence of faint auroral illumination of the polar type is responsible for the high correlation in April and November, probably through the excitation of nitrogen bands. At other times of the year the auroral green radiation appears to be the sole characteristic of the non-polar type.

It seems likely that some considerable portion of the differences noted by Lord Rayleigh at different stations on the same night are due to the admixture of continuous spectrum. As the accompanying table shows, the elimination of the continuous spectrum usually reduces the differences considerably; the first five columns are reproduced from Lord Rayleigh's paper (*Proc. Roy. Soc.*, A, **119**, p. 23; 1928).

Date.	Place.	Observed.			Reduced.		Differences.				Remarks.
							Auroral.		Blue.		
		Red.	Auroral.	Blue.	Auroral A.	Blue B.	Observed.	Reduced.	Observed.	Reduced.	
Jan. 16, 1926	England	−4·4	−1·4	+5·8	2·6	1·7	3·4	0·8	3·2	0·8	Reduced values show improved agreement. (Canberra values, $A=3·3$, $B=2·8$, agree well with Cape.)
	Cape	−1·9	+2·0	+9·0	3·4	2·5					
Mar. 2, 1926	England	−3·6	−0·2	+6·4	3·0	1·5	2·2	−1·2	1·3	−1·8	Difference persists. (No Canberra readings, moon nearly full.)
	Cape	−0·4	+2·0	+7·7	1·9	−0·3					
April 15, 1926	England	−3·6	−0·8	+6·4	2·4	1·5	3·2	1·9	1·9	0·7	Outstanding auroral difference probably due to auroral display in S. latitudes. (Canberra reduced values, $A=4·0$, $B=2·3$, agree well with Cape.)
	Cape	−2·4	+2·4	+8·3	4·3	2·2					
Sept. 19, 1925	Shetland (Lerwick)	−4·4	−2·8	+3·4	1·2	−0·7	4·5	3·7	3·0	2·2	Differences persist. Lerwick's readings outside range of experience at Canberra.
	England (Northumberland)	−3·6	+1·7	+6·4	4·9	1·5					
June 7, 1926	Hawaii	−4·7	−0·9	+5·1	3·5	1·3	3·0	0·6	2·8	0·5	Reduced values show improved agreement.
	Canberra	−2·4	+2·1	+7·9	4·0	1·8					

As Lord Rayleigh selected these pairs to emphasise the contrast between readings at different stations, it is likely that the bulk of the readings will not differ by nearly such large amounts after reduction. We have assumed that the instruments used elsewhere possess precisely the same qualities as ours and have used our own graphs for their reduction, but it would be an improvement, of course, to determine the correction curves separately for each instrument, *in situ*.

The nature of the continuous spectrum is itself of interest. From the parallelism between the distribution of energy in the night sky and the sunlit sky or moonlight, we look at once for an explanation on the ground of the diffusion of sunlight or moonlight, though the rotundity of the earth makes this difficult to picture. At the same time, we cannot overlook the possibility that this faint white radiation may

arise from some new form of auroral excitation originating perhaps outside the earth's shadow, or to the recombination of ions which had previously been separated.

The annual period is pronounced, the maximum with us occurring in May or June of each year. This suggests its association with the phenomenon known as the 'Gegenschein,' because it is at this season of the year that the sun is most nearly opposite the place of observation.

On some nights the sky appears to be of great brilliance. The outstanding feature is the smallness of the transmission through the red filter. The auroral green radiation is then relatively bright, but not absolutely large. The main criterion for a brilliant sky is thus the absence of a continuous spectrum.

A memoir embodying the observations made at Mount Stromlo in 1926 and 1927, together with a detailed account of the method of reduction outlined above, is in the printer's hands and will shortly be available for distribution. W. G. DUFFIELD.

Commonwealth Solar Observatory,
Mount Stromlo, Canberra,
Australia, Nov. 11.

The Electromagnetic Equations in the Quantum Theory.

IN spite of the great progress made in recent years, the theory of radiation is still in rather an unsatisfactory state. By the methods of Schrödinger it is possible to express the radiation of atoms in the form of electromagnetic waves, but the formulation is quite incomplete, because it fails to give the reaction of the radiation on the emitting system. The theory of Dirac (*Proc. Roy. Soc.*, **114**, p. 243) is free from this cardinal fault, but fails to show the relation of radiation to static electric force; it is in fact a valid theory of light, but scarcely an electromagnetic theory. It is of course quite probable that in a complete theory there is no need, or room, for radiation at all, in that the direct interactions of particles according to relativity principles will give all that is required; but radiation must always remain a convenient eliminant, expressive of the effect of a number of particles on a distant one. So it seems not out of place to fit the electromagnetic equations into the general scheme; if they are wrong, it is still interesting to know why Maxwell made the mistake of inventing them!

The following considerations suggest in a natural way how the equations arise. Although by Schrödinger's method it is possible to calculate the radiation scattered in the Compton effect, yet the method is incompetent even to express the idea embodied in the celebrated experiment of Geiger and Bothe (*Zeit. für Phys.*, **32**, p. 639), in which it was observed that the directions of scattering of electron and light quantum were absolutely correlated. The simplest way of making it possible to express such an idea is to endow the light with a set of co-ordinates X, Y, Z, T, and to have a wave function simultaneously involving both these and the x, y, z, t of the electron. Some such idea is also directly suggested by Dirac's theory, though he makes no use of actual co-ordinates.

The equation determining the behaviour of an electron in a field of radiation is, according to Dirac (*Proc. Roy. Soc.*, **117**, p. 610),

$$(p_0 + \alpha_1 p_1 + \alpha_2 p_2 + \alpha_3 p_3 + \alpha_4 mc)\psi = 0.$$

Here the α's are certain four-rowed matrices, and p_1 stands for $\frac{h}{2\pi i}\frac{\partial}{\partial x} + \frac{e}{c}V_1$, where V_1 is the first component of vector potential, while similar meanings connect p_2, p_3, p_0 with y, z, t. Now $\frac{h}{2\pi i}\frac{\partial}{\partial x}$ is symbolically the momentum of the electron, and it is therefore natural to regard eV_1/c as the momentum of the radiation. The equation then expresses the constancy of momentum in the interaction, and this is just what is used in working out the Compton effect by elementary principles. It is only a step to replace eV_1/c by $\frac{h}{2\pi i}\frac{\partial}{\partial X}$ as the symbolic momentum of the radiation. If now we have a field of radiation far away from the electron, the solution must split into two independent factors, and the radiation by itself will satisfy the equation

$$\left(-\frac{1}{c}\frac{\partial}{\partial T} + \alpha_1\frac{\partial}{\partial X} + \alpha_2\frac{\partial}{\partial Y} + \alpha_3\frac{\partial}{\partial Z}\right)\psi = 0.$$

When the values of the matrices are substituted, this equation is replaced by four which are exactly Maxwell's equations for free space, combined according to the rules:

$$\psi_1 = -iH_z,\ \psi_2 = H_y - iH_x,\ \psi_3 = E_z,\ \psi_4 = E_x + iE_y.$$

The only difference is that E and H must be real, whereas the ψ's are usually complex. In a recent paper (*Proc. Roy. Soc.*, **120**, p. 621), I pointed out this similarity, but at the time was unable to explain it.

This is, of course, only the germ of the matter, and it leaves many difficulties unsolved. Thus it will be immediately asked how the potentials V, which started as coefficients multiplying ψ, can be derived from part of the solution for ψ itself. The only answer that can be given is that the same sort of change occurs in other parts of the wave theory, when the reaction on a perturbing system is neglected. It will certainly be necessary to replace the term mc by some function of the co-ordinates, and, among other things, this should lead to an analogue to the classical calculation of electromagnetic mass; but to carry the matter further raises a very fundamental difficulty which I cannot overcome. We have not only two superposed *spaces*, but also two superposed *times*, and this is an idea that is very difficult to apprehend, for it, so to speak, dislocates the whole process. This difficulty is not special to the present work, but inevitably occurs in any relativistic representation of more than one particle. Since it may be some time (or should it now be *times*!) before this trouble is overcome, I have been emboldened to write the present communication, showing the outline of how we may hope that the old waves can be fitted, almost without change, into the new scheme. C. G. DARWIN.

The University, Edinburgh,
Jan. 17.

The Absorption of X-Rays.

THE atomic X-ray absorption coefficients of the elements have commonly been represented by simple formulæ of the type $\tau_a = kZ^x\lambda^y$ (k a factor involving fundamental atomic constants, Z the atomic number of the absorbing element, λ the wave-length of the X-rays, x and y exponents not very different from 4 and 3 respectively). These formulæ have been derived in a variety of ways (J. J. Thomson, A. H. Compton, L. de Broglie, H. A. Kramers), and the complete expression for the absorption coefficient of an element over all ranges or X-ray wave-lengths has been represented as the sum of a number of such terms—each term corresponding to the fluorescent excitation of a distinct series or sub-series ($K, L_1, \ldots$), and dropping out for wave-lengths longer than that of the corresponding absorption edge. Experimental determinations of the absorption coefficients have shown fair agreement with theory, both with respect to the general run of the coefficients on each side of a discontinuity, and to the magnitudes of the discontinuities.

In spite of this approximate agreement, it has become increasingly clear that the simplicity of the formulæ in no way reflects a corresponding simplicity in the absorption process. There is very complete evidence (Robinson, Skinner) that the 'partial' absorptions of the individual electronic groups and sub-groups vary with λ in a much more complicated manner than is suggested either by the older absorption theories or by the measurements. The close adherence of the measured absorption coefficients, over wide ranges of wave-length, to the 'λ^3 rule' (Richtmyer's precision measurements)—or to the similar rules with slightly different exponents, favoured by Allen and others—must therefore be regarded as a statistical effect, due to mutually compensating variations in the partial absorptions.

Most of the available data have been fully discussed (notably by Richtmyer and Compton) in relation to the older absorption theories. Newer theories (Wentzel, Oppenheimer) lead to more complicated formulæ, which allow for the above-mentioned deviations of the partial absorptions from the λ^3 rule. Unfortunately, these formulæ cannot yet be implemented in a sufficiently precise numerical sense, and further experimental data are urgently needed.

It may perhaps be stressed here that the direct measurement of absorption coefficients can contribute relatively little evidence to some of the points at issue. The contributions of (say) the L electrons to the total absorption for wave-lengths shorter than that of the K discontinuity can, it is true, be deduced from the absorption curves, but only by the most intrepid extrapolation; and although the measurements have been conducted with the utmost skill by a number of workers, there remain some obvious and (Bothe) other less obvious difficulties of interpretation, linked with uncertainties in the allowance to be made for the effects of scattering.

It has long been realised that the 'magnetic spectrometry' of the secondary cathode rays from the absorber can provide valuable evidence, supplementary to that of the absorption measurements. The method is particularly suitable for comparing (say) the absorptions of the L electrons of a heavy atom and the K electrons of a lighter atom—the atoms being so selected that the secondary electrons emerge with similar energies in the two cases (allowing only a sufficient difference for the clear resolution of the two sets).

We are now carrying out experiments on these lines. With absorbers compounded or mixed with the two elements in suitable proportions, a single experiment is often sufficient to fix approximately the relative absorptions of the two sets of levels in question. We find, for example, that the two K electrons of a zinc atom absorb probably more—and almost certainly not less—X-radiation of wave-length 0·56 A. than the eight L electrons of tungsten.

According to one empirical absorption law, the tungsten L electrons should absorb 4·8 times as strongly as the zinc K electrons. According to de Broglie's theory, which (Richtmyer) gives in many respects excellent agreement with the measurements, this ratio should be 5·2. An extension of Kramers' theory, which attaches diminished weights to electrons in 'orbits' of higher quantum numbers, partially, but insufficiently, reduces the discrepancy. On the other hand, Kramers' theory fits many of the direct absorption measurements less well than that of de Broglie. In any case, all theories so far proposed contain necessary simplifying assumptions which could account for deviations of the kind observed, and it would be unprofitable further to discuss them here.

The purpose of this note is simply to point out some of the difficulties of the problem, and to indicate the nature of some of the points on which we hope to bring more detailed information. The method of corpuscular spectrometry, while limited in some of its applications, is unusually flexible in other directions. This flexibility imposes an obligation to extend the measurements over a wide range of X-ray levels, and with a wide range of primary radiations—especially in certain important regions. The preliminary stages of the work have been unduly protracted by exceptional local conditions, but we now hope to proceed comparatively rapidly with the full programme—although at best the investigation will be a lengthy one.

The work has been assisted by a grant to one of us (H. R. R.) from the Government Grant Committee of the Royal Society, for which we here desire to make acknowledgment.

H. R. ROBINSON.
C. L. YOUNG.

University College,
Cardiff, Jan. 10.

The Nature of Martensite.

DURING the past few years several papers have been published on the nature of changes in carbon steel during the processes of quenching and tempering.

The dilatometric investigations of Haneman and Traeger[1] have shown that during the process of tempering of quenched steel there exist three transition points: 100°, 235°, and 300°. The X-ray study has shown that tetragonal martensite disappears at 100° C. The second transition point (235°) on the Haneman's and Traeger's curve, also confirmed by X-ray investigations, is the temperature of transformation of austenite. At 300°, iron carbide, Fe_3C, is formed.

According to Honda's theory, the first transition point (100°) is accounted for by the transformation

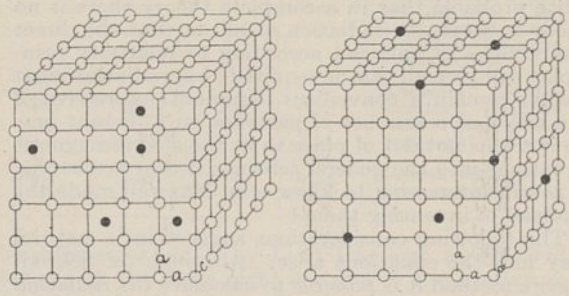

FIG. 1.

of the tetragonal lattice of the martensite into a cubic one, and we think that the arrangement of the carbon atoms in these two forms of martensite is the following:—

In tetragonal martensite the positions of the carbon atoms are definite, and they are situated at the centres of those faces which are perpendicular to the tetragonal axe (see Fig. 1*a*).

In cubical martensite the positions of the carbon atoms are not fixed. Some of them replace the iron atoms in the lattice, and some are situated at the centres of the faces (Fig. 1*b*). Any assumption that all carbon atoms should be situated at the centres of the faces would give a density considerably higher than is obtained experimentally.

Kurdumow and Kaminsky[2] have shown that the ratio of the axes of the lattice of the tetragonal martensite increases with the increase of the carbon

[1] Haneman and Traeger. *St. und Eisen*, p. 1508; 1926.
[2] G. Kurdumoff and E. Kaminsky. NATURE, Sept. 29, 1928.

contents in steel. Honda and Sekito,[3] however, have obtained from their experiments that the value of this ratio is independent of the contents of carbon, and that the ratio is equal to 1·07.

This result of Honda and Sekito is contrary to the well-known fact of the diminution of volume change of quenched steel with decrease of carbon contents. From Honda and Sekito's data we can conclude that in quenched steel with carbon content 0·2 per cent, the volume of tetragonal elementary cell is 5 per cent larger than the volume of an elementary cell of α iron. This is entirely contradictory to results of Matsushita[4] and Birnbaum,[5] who investigated the changes of volume of steel with small contents of carbon during the process of tempering. Matsushita and Birnbaum were also unable to obtain a transition point near 100° for steels with carbon content 0·2 per cent.

Prof. Honda has kindly informed me by letter of certain details of his and Sekito's experiments. According to that letter "Sekito placed the specimen in a porcelain tube, one end closed, packed with charcoal powder, and heated it in an electric furnace." In such conditions, surface cementation might take place, and that would give equal values for the ratio of axes for tetragonal martensite in specimens of steel with different contents of carbon. In fact, the constant values for the ratio of axes obtained by Honda and Sekito probably mean that the content of carbon in the surface-layers was the same in all cases.

The broadening of the spectral lines in the case of martensite, Honda and Sekito explain by the presence of the carbon atoms in the lattice. The presence of a carbon atoms changes the dimensions of the cells which they occupy, and exerts an influence on the dimensions of the surrounding cells, giving an irregularity in the lattice.

We entirely agree that such irregularity of the lattice is very probable in the case of martensite.

Now Debye[6] has shown that the heat movements of atoms in the lattice produce a decrease in the intensity of the spectral lines. In martensite, therefore, in this solid solution, the irregularities in the positions of the solvent atoms produced by the solute atoms give a continuous variation of the lattice parameter, and therefore also cause only a decrease in the intensity of the spectral lines, but not the broadening of them.

N. SELJAKOW.

Leningrad,
Sosnowka 2,
Physico-Technical Laboratory.

Raman Effect in Gases.

SINCE the discovery of the Raman effect in scattered light, investigation has been extended to a large number of substances in the solid and liquid state. So far as I know, practically nothing has been done on gases, if we except an observation on ether vapour by Ramdas. Of course, the main difficulty in the case of gases consists in the extreme weakness of the scattered radiation.

Using a very luminous spectrograph (aperture of camera lens 1 : 2·7) I have obtained plates which show Raman spectra of different gases. The light source employed was a mercury arc, and the exposure time was 48 hours, using gases at atmospheric pressure. The length of the spectrum on the plate was 16 mm. from λ3650 to λ5461; wave-lengths were measured by comparison with a copper arc spectrum.

This research is being carried on, and will be extended to a larger number of gases, and, if possible, with a more dispersive apparatus. But the results already obtained with carbon monoxide and carbon dioxide are perhaps worth a short notice.

Carbon monoxide shows two Raman lines at about λλ4432, 4810. They correspond evidently to the same quantum transition, excited by both λ4046 and λ4358 of mercury; the differences in frequency between the Raman lines and the exciting lines are found to be respectively 2154 and 2156 cm.$^{-1}$ (the agreement being better than is to be expected with the dispersion used), and this corresponds to an infra-red absorption band at 4·64 μ. In fact, a double band, with the centre at 4·66 μ, has been found in the absorption spectrum of carbon monoxide, so that there can be scarcely any doubt about the origin of the observed Raman lines.

The behaviour of carbon dioxide is quite different. The infra-red absorption spectrum consists mainly of three bands (each of which has a structure, depending on rotation states) at 2·7, 4·25, and 14·7 μ. These are interpreted by C. Schaefer and Philipps as being the three fundamental oscillation frequencies of the triatomic molecule.

Now, in the Raman spectrum no lines were found corresponding to any of these absorption bands, though they would all have fallen in the region of spectrum photographed. I observed instead two doublets, at λλ4639, 4616 and λλ4289, 4268, excited respectively by λ4358 and λ4046. They correspond to transitions of 1284 and 1392 ($\pm$ 10) cm.$^{-1}$, which have not been observed in absorption even through very thick layers of the gas.

A rather surprising coincidence appears, however, if we calculate the differences in frequency between the two components of the double band at 2·7 μ and the band at 4·25 μ (which has a much smaller separation). We find the values 1279 and 1381 cm.$^{-1}$, which agree within the limits of experimental error with the two frequencies given above.

One example is not enough to prove that this coincidence has a physical meaning, but it is a remarkable fact anyhow that none of the strong absorption bands of carbon dioxide appear in Raman effect. Investigation extended to other substances will show if really, for some types of molecules, not the infra-red absorption frequencies themselves, but only their combinations, appear as a Raman shift in the scattered radiation.

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An Apparently Anomalous Raman Effect in Water.

CARRELLI, Pringsheim, and Rosen (*Zeits. für Physik*, **51**, 511; 1928) have shown that the Raman scattering by water molecules yields only one modified frequency, corresponding to an infra-red band at 2·90μ. This modified frequency has, at first appearance, two anomalous aspects: (1) the modified 'line' is really a broad band of approximately 500 cm.$^{-1}$ width, in contrast to the sharpness of Raman lines produced by organic liquids; (2) no infra-red band corresponds exactly with the centre of the observed scattered band, the nearest one being the strong 3·0μ infra-red band.

I believe that the Raman spectrum of water is not anomalous in either respect. In 1927 (*Phil. Mag.*, **3**, 618; 1927) I presented an argument, based largely on an attempted correlation of the water bands below 3μ, in which it was pointed out that the strongest infra-red band, the one at 3μ, was probably double, being made up of an overtone of the 6·1μ band and a new fundamental. I tentatively assigned a wave-length value of 2·9μ to this fundamental, and believe

[3] K. Honda and S. Sekito. *Sc. Rep. Tôhoku Imp. Univers.*, **17**.
[4] Matsushita. *Sc. Rep. Tôhoku Univ.*, **7**, 43-52; 1918.
[5] Birnbaum. *Archiv. für Eisenhut*, Heft 1, Juli, 1928.
[6] P. Debye. *An. d. Physik*, **43**, p. 49; 1914.

that it is this fundamental band which shows up in the Raman spectrum. The overtone of the 6·1μ band would not be expected to appear since its fundamental does not occur. This appearance in the Raman spectrum of one fundamental and the absence of a second is believed to occur analogously in the scattered spectrum of ammonia in water solution (Carrelli, Pringsheim, and Rosen, *loc. cit.*) and of organic liquids (Pringsheim and Rosen, *Zeits. für Physik*, **50**, 741 ; 1928).

Again, the comparatively great breadth of the scattered water band is, after all, quite consistent with the breadth of the infra-red bands of water. I have measured, for example, the width of the 1·46μ water band (probably the first overtone of the 2·9μ band with possible other bands superposed) and have found it to be 800 cm.$^{-1}$ wide. This is somewhat broader even than the 2·9μ band found in the Raman spectrum.

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A New Type of Alum.

THE close external crystallographic similarity between potassium sulphate and potassium beryllium fluoride, K_2BeF_4, has previously been pointed out by Fedorov and Barker. Both salts crystallise in the orthorhombic system, and are pseudo-hexagonal. Adopting standard orientation, the respective axial elements are: For K_2SO_4, $a : b : c = 0{\cdot}7418 : 1 : 0{\cdot}5727$, and for K_2BeF_4, $a : b : c = 0{\cdot}7395 : 1 : 0{\cdot}5708$. It has further been suggested that, since the salts exhibited some structural analogies as indicated by the formulæ, this external similarity might be accompanied by true physical isomorphism. (The well-established isomorphism in the exactly analogous series $NaNO_3$ – calcite and $KBF_4 - KClO_4 - BaSO_4$ is of interest in this connexion.)

Further definite evidence with regard to this question has now been obtained. On allowing an aqueous solution containing equimolecular quantities of potassium beryllium fluoride and aluminium sulphate to crystallise at the ordinary temperature, it was found that crystals of the composition $K_2BeF_4 . Al_2(SO_4)_3 . 24H_2O$ were deposited. This salt crystallises in the cubic system, normally as octahedra, and is a true alum. It readily forms true overgrowths on the common alums, for example, chrome alum. A similar alum is obtained when potassium zinco-chloride, K_2ZnCl_4, is substituted for K_2BeF_4. The existence of these alums shows clearly that potassium sulphate and potassium beryllium fluoride are truly isomorphous.

Rubidium beryllium fluoride, Rb_2BeF_4, forms crystals which are isomorphous with those of the potassium salt. Pseudo-hexagonal interpenetration triplets are frequently formed as thin flakes. In these triplets the individuals are tabular on $a(100)$, the flakes being bounded by the form $q(011)$. In many cases the form $q(011)$ is absent, and is replaced by the form $o(111)$, bevelling the flake edges. The double refraction is weak and positive. The optic axial plane is $b(010)$, the acute bisectrix being the a-axis. Exactly analogous interpenetration is characteristic of potassium sulphate, and hence this triplet formation is significant. In the case of potassium sulphate, where the accurate measurements of Tutton are available, the twinning is described as taking place on a plane perpendicular, not to the actual $q(011)$ face, but to an idealised $q(011)$ face corresponding to a true hexagonal structure, *i.e.* twinning occurs as if the angle $011 : 0\bar{1}1$ were accurately, not approximately, 60°.

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The Methodology of the Inexact Sciences.

THE reply to my letter under the above heading (NATURE, Jan. 26, p. 130) rather misses my point. I was not discussing those points of contact between Mithraism and Christianity for which there is historic evidence, such as the ideas which Tertullian accused the former of borrowing from the latter. My contention was that in the particular example which I quoted the evidence was based on the fallacy—let us call it 'philonism'—which consists in attributing undue significance to the analogies or parallels that can be drawn between every two groups of ideas.

I have made the alarming discovery that you, Sir, the editor of NATURE, are simply a mythical survival of Mithraic beliefs. We have been accustomed to regard you as the champion of the light of science which is to prevail over the darkness of error and superstition, but this popular notion is clearly a survival of the legendary victory of Ormazd over Ahriman with which Sol Invictus Mithras was associated. The astrological notions which pervaded Mithraism survive in the attribution to you of pseudepigrapha dealing with astronomical subjects and the reformed calendar which we now enjoy, and also in the design at the head of the cover of NATURE. But perhaps the clearest evidence for my thesis is to be found in the prominent rôle assigned to you by common rumour in the orgiastic rite known as the Feeding of the Lions, an esoteric mystery which is practised during the meetings of the British Association. In this rite the spelæum of Mithras is represented by a room in a tavern, where the initiates consume with elaborate ceremony the flesh of a sacrificial bull. The dog which made possible the sacrifice of the bull by Mithras is here known as the 'jackal,' the sinister activity of the scorpion is imitated by the wagging of coat-tails, there are libations, and the torch-bearers common on Mithraic monuments are represented by the ceremonial burning of tobacco with which the orgy concludes.

At first I was unable to account for the title "The Red Lions" assumed by the initiates, and derived, according to popular tradition, from the public-house in which their first meeting was held. On referring to an authority, however, I find that "Lion" was the title assumed by devotees of Mithraism on reaching full initiation. It was not until he had passed through the degrees of Corax, Cryphius, and Miles that the initiate might attain to that of Leo, which entitled him to full participation in Mithraic mysteries. The crudeness of the popular story about the Red Lion public-house at Birmingham is thus only too apparent.

With this horrible example before me I do feel that the study of comparative religion ought to be purged of the philonistic fallacy. The other science in which that fallacy mainly occurs—namely, analytical psychology—is past praying for in the Mithraic or any other liturgy.

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Dr. J. W. L. Glaisher.

WILL you allow me to add a few points supplementary to the very full obituary notice of the late Dr. Glaisher, which appeared in NATURE of Jan. 26. One outstanding trait of his character was his extreme accuracy, which often made him undertake a journey to London to settle a minor historical or bibliographical point by referring to the actual books, when only quotations or copies of titles were available to him. His "Report on Mathematical Tables" (1873) perhaps best illustrates this characteristic. The Report is marvellously complete, and it would be very difficult to discover a mistake in it. Those who

have undertaken work of this kind will understand the difficulty of producing such a flawless work.

Besides pottery, Dr. Glaisher also collected arithmetical books of the fifteenth and sixteenth centuries, and his collection is probably the most complete one in private possession in Great Britain. Dr. Glaisher, however, was no mere book collector, but read all his books (whatever the language), and to good purpose, as his articles in the *Messenger of Mathematics* amply show. One of these, "On the Early History of the Signs + and −, and on the Early German Arithmeticians" (1921–22), will prove a mine of information to historians of mathematics, who cannot possibly read all the books themselves. Dr. Glaisher had a keen sense of humour, which enabled him to enjoy the human interest found even in such supposedly dry books, and he would often express his amusement of the vinous questions and problems abounding in the works of Adam Riese and Stifel. His collection of mathematical books, as he informed me, he bequeathed to the library of his college.

This did not exhaust Dr. Glaisher's activity as a collector. Two other collections he formed and prized, both very far afield from the realms of science, but characteristic as showing his varied human interests. One was of children's books with movable figures, and the other (a very complete one) of valentines. But whether these also were left to Trinity College, Cambridge, I do not know.

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Stellar Spectra in the Far Ultra-Violet.

IN a letter to NATURE of Nov. 24, 1928, Cario suggested that in the region of arctic winter-night the 3000 A. barrier of stellar spectroscopy may be absent, leaving a clear view down to 2100 A., where absorption by ordinary oxygen molecules sets in. To test this idea I have made a trip to Honningsvåg, in northern Norway, the expenses being borne by the Government Research Fund of 1919. Honningsvåg is a small fishing-village in the vicinity of the North Cape (lat. 71°, long. 26° E. approximately). At this place the sun is constantly below the horizon from Nov. 20 to Jan. 23. I stayed there from Dec. 5 to Dec. 11. Being primarily interested in large-scale variations in the atmospheric transmission, I brought only a rather crude equipment, consisting of a small objective single prism quartz spectrograph equatorially mounted on tripod, with a 3-in. guiding telescope fitted with a hand-driven gear. The length of the spectrum obtained by this instrument is about 8 mm. from 5000 A. to 3000 A., and the dispersion at 3000 A. about 100 A. to a millimetre.

The principal result of the trip is that Cario's conjecture has thus far not been confirmed. I photographed the spectra of several early type stars having relatively much radiation in the ultra-violet (α Lyræ, γ Cassiopeiæ, η Ursæ Majoris); but the spectra are cut off near 3000 A. in all cases. This result appears to vitiate the hope of penetrating beyond the 3000 A. barrier, at the same time as it may lend enhanced interest to the problem of atmospheric ozone. The equipment was insufficient to determine the height and thickness of the ozone layer, and it may be that Cario's idea is right in so far that ozone is no longer situated at the height of 50 km. found in lower latitudes. In this connexion it may be remarked that Honningsvåg is situated in the auroral belt, and from the auroral spectrum we infer that in this region free oxygen atoms will be present at a height of 100 km. and upwards. It is natural to infer that where monatomic and diatomic oxygen exist there will also be formed ozone, and that during the arctic night the ozone layer rises to greater heights than usual. It is hoped to look further into this problem on a later occasion.

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Zoological Nomenclature.

IN accordance with the provisions governing possible suspension of the rules, the undersigned has the honour to invite the attention of the zoological profession to the fact that application for suspension of the rules has been made in the case of *Nycteribia* Latreille, 1796, monotype *Pediculus vespertilionis* Linn., 1758. The Commission is requested to set aside the monotype designated in 1796 and to validate *Nycteribia pedicularia* 1805 as type of *Nycteribia*. *Pediculus vespertilionis* Linn. was based on an acarine (described and figured by Frisch, 1728) which is now classified in *Spinturnix*. Latreille was dealing with an insect which he erroneously determined as *Pediculus vespertilionis*. Unless the rules are suspended, *Nycteribia* should be transferred from the Diptera to the Acarina and should supplant *Spinturnix*; this would cause extreme confusion and upset generic and supergeneric nomenclature which has been accepted without challenge for about a century.

A vote on the foregoing proposition will be delayed until about Jan. 1, 1930, in order to give zoologists interested in the case ample opportunity to express their opinions, *pro* or *con*, to the International Commission on Zoological Nomenclature.

C. W. STILES
(Secretary of Commission).

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Science and Life.

THE attitude taken by Mr. Aldous Huxley, as described by Major Church in NATURE of Jan. 5, p. 6, does not strike me as altogether novel. Was it not given—and I think with implicit condemnation—by Matthew Arnold in four unsurpassable lines of "The New Syrens":

> "Hath your wisdom felt emotions?
> Will it weep our burning tears?
> Hath it drunk of our love-potions,
> Crowning moments with the wealth of years?"

Arnold's 'wisdom' did not connote science: but psychologically the parallel is close. It is one of time's and heredity's ironies that Mr. Huxley is grandson of one of that band of scientific friends who, with their wives, sometimes resorted to the woods and read poetry aloud; and, if memory do not play me false, the great Huxley on one such occasion read "Denone." Those great scientists' wisdoms could and did feel emotions at any rate.

FRANK H. PERRYCOSTE.

Polperro, Cornwall, Jan. 13.

The Green Ray.

As seen from my house at St. Leonards, the sun sets at sea up to about this date, and behind the South Downs from now onwards. Only in the latter case have I been able occasionally to observe the greenishness of the last ray, and then indistinctly, owing no doubt to the habitual want of clearness of the atmosphere over the Downs at sunset. To-day the sun set behind the sloping face (as it appears from here) of Beachy Head. The ray was pure green.

T. S. DYMOND.

St. Leonards-on-Sea,
Sussex, Jan. 19.

Oyster Cultivation and Related Researches in the British Isles.

By Dr. J. H. ORTON.

A VERY small proportion of the oysters sold in the British Isles is taken directly from public grounds inshore or offshore. Natural offshore oyster beds become fished out soon after they are found, as a result of indiscriminate fishing, and inshore public beds suffer the same fate unless fishing is suitably restricted. The difficulties in enforcing culture on public grounds have led to the leasing of the chief oyster beds in Britain to private individuals or companies or corporate bodies. Thus the bulk of the oyster supply is produced by oyster cultivation of some kind.

The English native oyster (*Ostrea edulis*) is in its essential characters the same as the Dutch and the flat French oyster, therefore young Dutch and young flat French oysters may be laid down on English beds to grow and wax fat, and then be only recognisable as of foreign origin by an expert. Large numbers of the Portuguese oyster (*Ostrea angulata*) are now produced in France, and an increasing number is being imported into England and sold after remaining on English beds for one or more years. American oysters (*Ostrea virginica*) are also imported from Canada and America, and similarly relaid and sold after remaining on English beds for one or more years. Neither of these two latter species breeds naturally in any quantity in England. Thus oyster production in England is concentrated chiefly on *Ostrea edulis*.

In the British Isles, oyster cultivators fall into two chief groups, namely, one concerned in producing young oysters in great quantity and rearing them to an age of 2 to 4 years for sale to the other group, whose business it is to buy medium-sized oysters, grow them, and place them on the market in a plump or fat condition: the former are oyster producers; the latter, oyster merchants. On some producing grounds suitable portions of the beds may be utilised for rearing oysters for direct sale to the public, while on well-stocked fattening grounds good crops of young oysters may sometimes be obtained. Other beds, which have been condemned as being liable to pollution by sewage, may still be used for oyster culture, but all oysters produced on them must be transplanted for purification[14, 17] before being offered for sale for consumption.

NATURAL OYSTER CULTIVATION.

The cultivation of oysters (hereafter assumed to be *O. edulis*) may be considered in three natural stages: (1) oyster production, (2) growth culture, (3) fattening, but during all these stages the care of the beds forms an important fourth section of the work.

Oyster Production.

Individual female-functioning English oysters (*O. edulis*) produce from a few hundred thousand to about 1½ million eggs in a breeding season, according to the size of the individual. The eggs are laid inside the shell and are retained there by the parent until they develop into freely swimming individuals (*larvæ*) which, after a short hazardous life, 10 days or more,[1] in the tidal streams, settle down on any suitable clean object and transform themselves into the sedentary young oyster, which at this stage is called an oyster *spat*. The season's settlement of young oysters is thus called a *spatfall*.

The primary object of the oyster producer is to secure a large spatfall. To attain this object the oyster cultivator must know the main facts regarding breeding and the best conditions for the settlement of the larvæ, and must keep a reasonably large stock[2] of large spawning oysters to ensure a spatfall in only moderately good seasons. The beginning of the breeding season in *O. edulis* varies locally and with season according to the weather conditions from about the middle of May to the beginning of July. On English beds it has been found that breeding begins in a fair proportion, 10 to 20 per cent[3] of the population, soon after a temperature of 60° F. or above is maintained in the bulk of the seawater. In practice the oyster cultivator examines[4] samples of oysters at about the usual time breeding begins in a particular locality until a small proportion of blacksick[5] oysters are found. A *blacksick* oyster is one containing larvæ which appear black in mass, in which condition they are ready to begin a free existence (Fig. 1).

FIG. 1.—Photograph of a 'blacksick' oyster. The semi-lunar shaped black area in the upper right part of the shell is composed of hundreds of thousands of shelled larvæ. Individual larvæ may be distinguishable with a lens in the original on the lower middle part of the shell. (× *ca.* ⅔.)

As soon as a small percentage[6] of blacksick oysters are found, a previously prepared quantity of clean shell is gradually spread day by day over those portions of the beds known to have secured spatfalls in other seasons. Any kind of clean material, but especially shell, whether of cockles, oysters, mussels, limpets, or clean shell-gravel, and collectively called cultch, may be used. Twenty tons of this material is easily absorbed on even small beds. The English method of catching spat by merely throwing clean shell into the sea is very

simple and primitive in comparison with continental and other foreign methods,[7] but is defensible on the high cost of labour in this country and the (im)probability of adequate economic return on outlay on extra labour costs.

After the distribution of the cultch, the oyster cultivator, like the farmer on land, is—except for nursing the beds—largely at the mercy of the weather. After a long fine summer a good fall of spat may be expected on most well-stocked beds; but the spatfall may fail in some good summers, or in other rare cases be so prolific as to bespatter almost every available object, including some fucoid seaweeds. In cold summers a good spatfall is not expected. These facts prove that certain special conditions, which do not always occur in the sea, are requisite for the proper development of the larvæ and/or the transformation which occurs when the active larva settles down to become the sedentary mollusc. In a good season, upwards to 30 spat on an oyster shell may be found about the middle of July; in a poor one, shells with 2-5 spat may be difficult to find, and, except in prolific seasons, there is probably a heavy mortality at this stage.

Growth Culture.

When the cultivator has obtained a good spatfall, the young oysters are left on the ground undisturbed until at least the following winter or spring, and usually until the size of one inch or more is attained. At about the size of 1½ to 2 inches, the young oysters in the sea begin mostly to grow away from the cultch shell, and can then be, and are, freed therefrom with a knife, one of the operations known as *culling*. Culling the young oysters from cultch is an important operation and permits the animal afterwards to grow into a good shape, that is, with a deeply concave as opposed to a flat shell. After being culled, the young oysters may be returned to the original bed, or relaid on special nursery beds kept for particular size-groups, and left to grow under supervision until required for sale or relaying on fattening beds. Well-shaped oysters grown in the sea rarely attain to more than a length of one inch at an age of one year,[2] and afterwards on the average increase in size (length) with a decreasing yearly increment; on the other hand, flat-growing oysters may grow in length at a greater rate than one inch per year. In the sea, increase in shell area occurs in the spring and again in late summer or autumn, as is especially well shown on the Fal Estuary Beds. In the apparent dormant period in summer there is some reason to believe[8] that the shell may be increasing in thickness. Well-shaped oysters usually grow slowly in size, and rarely attain marketable size before having spent five summers in the sea.

Fattening.

The natural fattening of oysters consists simply in relaying stock on whole beds or parts of beds where previous experience has shown that fattening will usually occur. The oysters fatten themselves naturally, but in the sea there are also good and bad years for fattening, although certain beds rarely fail. Fattening depends ultimately upon the occurrence of an abundant supply of microscopic vegetable food, especially diatoms and peridinians.[9, 10]. In the sea the amount of this food available shows fluctuations,[9, 11] with usually maximal growths in spring and late summer or autumn, and the natural fattening of oysters at the approach of winter is believed to be dependent upon the later maximum.[9] In France, oysters are artificially fattened in ponds or *claires* by feeding them with a superabundance of diatoms. If, therefore, by artificial means a superabundance of microscopic vegetable organisms could be produced cheaply in restricted estuarine localities in the sea, the fattening of the contained oysters, if these were otherwise healthy, would be assured.

In spring and summer the food absorbed is utilised largely in the formation of reproductive products. When an oyster is ready to spawn it is usually in fine fat condition, but in this condition the fatness is due to the great development of eggs or sperm, whereas the fatness attained on the approach of winter is quite different[9] and due to an accumulation of food reserves.[12]

Care of the Beds.

During all the preceding phases of oyster culture a constant watch on the beds is maintained for the purpose of collecting and destroying pests and enemies, such as, on one hand, slipper-limpets, mussels, ascidians, and on some grounds the larger seaweeds, and on the other hand, the oyster-borers, *Murex*, *Purpura*, and *Urosalpinx*, and starfishes. Muddy beds may need to be harrowed, and sandy beds inspected after a succession of gales, or after gales of unusual severity, while constant supervision may be required to prevent or detect poaching.

ARTIFICIAL OYSTER PRODUCTION.

The well-known fact that one individual *O. edulis* at an age of about six years may incubate one million or more young to an advanced stage of development has presented an alluring prospect of easily acquired wealth to experimental cultivators for more than half a century. Many attempts have been made in the past in specially constructed oyster ponds and tanks to obtain young oysters from the millions of larvæ which can easily be obtained in such ponds or tanks, but with economic failure. Large spatfalls have been obtained in some years, followed by complete failure in many others. Such experiments in the past, however, have been based on empirical procedure, and there is no reason to suppose that success will not ultimately be attained as the factors concerned in promoting (1) the healthy life of the larvæ, (2) an easy transformation of the larva to spat, and (3) an assured early development of the spat become known. The experience gained in rearing the larvæ of sea-urchins, crabs, ascidians, limpets, worms, and even crabs at the Plymouth laboratory,[13] all tends to show that the undertaking is more difficult than would be anticipated. The difficulty is also

generally greater when there is—as in the case of the oyster—a metamorphic stage in the development, at which stage there is generally a very great mortality. Academic researches on rearing marine animals have, however, been made only on a small scale, and additional difficulties arise when it is necessary to carry out experiments in a large volume of unchanged—but changing—water.

In recent years the Government Fisheries Department has attacked the problem of the artificial production of oysters in the mussel purification tanks at Conway, with variable, but probably greater, success than has attended previous efforts. The Government experiments were begun on empirical lines in the post-War period, but are now being continued on a scientific plan,[14] which is taking into account all the factors likely to affect a successful issue, such as nature of the larval food, constituents of the water, enemies, as well as temperature conditions; ultimate success in obtaining falls of millions of spat is probably only a question of time. The recent recognition of the importance of the minor chemical constituents[15] of sea-water, especially in a stationary body of water, has widened the scope of these experiments, but at the same time narrows down the possible unknown factors. The problem is thus expanding beyond the province of the biologist, and whether the original staff is big enough—even with hearty outside co-operation—to press the investigation with vigour may be reasonably doubted.

The original idea of these experiments was to discover whether oysters could be produced in bulk in tanks on a commercial scale. Oysters have been produced in large quantities, but the commercial aspect has not yet been sufficiently considered. Millions of oysters may be procured in tanks, but unless a reasonable proportion are eventually put on the market at a profit, the project is commercially unsound. It is desirable, therefore, that a large-scale commercial experiment should be carried out side by side with investigations into the exact conditions for ensuring a large spatfall.

Artificial Fattening.

The success of continental cultivators in fattening oysters artificially leaves no doubt that the same process—if commercially desirable—could be carried out in England by supplying a superabundance of diatoms in tanks or ponds. Such oysters are, however, usually green-gilled, and are not favoured by the English consumer, so that the problem in artificial fattening in England would comprise also the production of a white 'fish.' Recent researches,[10] however, indicate that a superabundance of diatoms and/or peridianians might be obtained in closed estuarine waters by artificially maintaining the slight concentration of essential foodstuffs, phosphates and nitrates, necessary for heavy crops of this planktonic vegetation. Supplied with abundant food of this nature, oysters would fatten naturally and with a minimum of outlay on labour.

Research Problems.

The main research problems in connexion with oyster culture are those concerned with increasing the stock of young individuals and with fattening oysters for the market. While the artificial production of young oysters may eventually be an assured commercial proposition, it is possible that slight improvements in the methods of securing oyster-spat on the natural oyster beds may rival even successful artificial methods in the ultimate return on outlay. Experiments on the treatment of shell-cultch before distribution in the sea, and novel methods of catching spat in the sea are reasonable problems for research.

The liaison between the oyster cultivator and the Fisheries Department is rendered difficult by the private or semi-private nature of most oyster-fisheries, but mutual benefit would undoubtedly follow if a young Government oyster-biologist were assigned the special duty of studying and conducting continuous researches on oyster culture and its problems in all parts of Great Britain. The biologist would be able to help the practical man in everything relating to biology, such as sex, spawning, development, spatfall, feeding, exposure dangers, etc., and in return would learn a great deal about the bionomics of the oyster in its relation to culture,[16] the local problems in oyster culture, and would eventually become a beneficent expert.

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Vitamin D and the Structure of Human Teeth.

IN a recent review in NATURE (Vol. 121, p. 325; 1928) on the influence of diet upon the teeth, reference was made to the work of M. Mellanby and her collaborators on the effect of diet on the structure of the teeth and on the incidence of caries. More recently the same author has brought forward evidence indicating a definite relationship between structure and the incidence of caries, and has also shown that it is possible to arrest the spread of this condition by suitable alterations in the diet (M. Mellanby, *Brit. Dental Jour.*, Dec. 15, 1927; M. Mellanby and C. L. Pattison, *Brit. Med. Jour.*, vol. ii, p. 1079; 1928).

An analysis of the results obtained from the

microscopic examination of sections of deciduous teeth showed that only 372 out of 1036 sectioned were normal or nearly normal in structure: 27 per cent of these had carious cavities; on the other hand, of the 664 which showed definite defects of structure, or hypoplasia, no less than 85 per cent were carious. The relationship held with each individual type of tooth: thus the incisors, which are usually the best calcified, showed the lowest incidence of caries, whilst the second molars, which are the worst calcified, were the most susceptible. A similar relationship between structure and caries was observed in the examination of 266 permanent teeth. About 10 per cent of each of the different type of teeth appeared to be exceptions to this relationship, a well-calcified tooth showing caries or vice versa. Apart from the fact that some of these exceptions may be more apparent than real, since the classification of a tooth depends on the structure of the part not affected by caries, and this may be well calcified, the disease having commenced in the badly calcified portion, there is a further factor to be taken into account, the possible change in the resistance of the tooth after eruption. Analysis of the structure of the secondary dentine formed in response to disease or injury showed that, in two-thirds of these exceptions, the presence or absence of caries could be correlated with a poorly formed or a well calcified secondary dentine respectively. This latter observation has a further importance in that it indicates that the resistance of the teeth can be changed after eruption by variations in the degree of calcification of the newly-formed dentine: one factor, and probably the most important, is the diet.

In previous investigations, Mellanby and Pattison have shown that diets favourable to calcification limited the initiation and spread of caries in children and frequently caused a hardening of teeth in which caries had started. In these experiments the diets were improved by giving milk, eggs, and cod-liver oil, thus supplying both vitamins A and D, or were made less satisfactory by increasing the oatmeal content or cutting down the vitamin intake. The present work was undertaken to see whether the good effect of cod-liver oil, for example, was due to its vitamin A or vitamin D content: it appears to show that vitamin D has a marked influence in preventing the spread of caries in children and in promoting its arrest, whilst vitamin A probably has no, or only a slight, effect.

The work described deals with the influence of vitamin D, supplied in the form of irradiated ergosterol (1 to 4 c.c. radiostol solution daily). A group of 21 children was placed on a complete average diet, supplemented by the addition of the irradiated ergosterol: the test lasted twenty-eight weeks and the amount and extent and degree of hardness or softness of each carious area were noted in each child at the beginning and end of the experiment. The average age of the children was less than six years. The results obtained were somewhat better than in the previous tests and showed that the addition of the vitamin D had a pronounced effect in preventing the initiation of new carious foci, limiting the spread of the disease, and apparently arresting its progress in many cases. Owing to the younger age of the children of this group, however, somewhat better results might be expected, since there is presumably less interference with the pulp tissue of the teeth by the natural processes of root absorption which occur at a later age.

When only the results obtained with children less than six years of age in the previous tests were compared with those of the present experiment, it was found that the radiostol supplement was only slightly more effective than the addition of cod-liver oil, extra eggs, and milk to the diet. Thus the average number of teeth per child showing initiation or increase of caries was 1·0 and 1·4 respectively in these two groups; on the diet containing little fat soluble vitamins and additional oatmeal the figure was 5·0 teeth per child; whilst on a diet containing no oatmeal and only a moderate quantity of fat soluble vitamins it was 3·3. The average amount of hardening or arrest of caries per child was, in the four groups, 3·9, 3·7, 0·2, and 1·2 respectively. Put in another way, the 21 children had 185 carious teeth at the beginning of the investigation: 4 new points appeared during the experiment, 2 in one child: 16 areas showed some spread of the disease, 4 being found again in one child, who was apparently given too little of the irradiated ergosterol. In the majority of the teeth the soft and active caries was in course of arrest, or had actually been arrested, so far as could be ascertained. Microscopic examination of some of these teeth indicated that the process of healing was accompanied by the laying down of well-calcified secondary dentine.

If these results can be confirmed in adults, they will be of great importance owing to the widespread prevalence of caries among civilised populations to-day. In a recent review on the subject of the influence of diet upon the teeth, M. Mellanby discusses the question whether the incidence of caries can be explained by the nature of the diets consumed, and concludes that such may indeed be the case (*Physiol. Reviews*, vol. 8, p. 545; 1928). The two factors which favour the development of caries are the consumption of large quantities of cereals and the small intake of the foodstuffs which contain vitamin D, milk, butter, cheese, and eggs. If an inadequate intake of this vitamin is only a partial cause of the prevalence of caries, this deficiency must be very widespread amongst all grades of society in civilised nations to-day.

It will be of great interest to see if the spread of caries can be prevented by the administration of irradiated ergosterol in some form to adults: if, as seems probable, this will be the case, then a simple method of preventing dental decay will be available and will be a great stimulus to an increased consumption of milk and milk products, with further benefits to health and well-being, or, for those who prefer it, the diet can be supplemented by a synthetic vitamin D preparation.

Obituary.

SIR W. T. THISELTON-DYER, K.C.M.G.

WILLIAM TURNER THISELTON-DYER, son of Dr. W. G. Thiselton Dyer, was born in Westminster on July 28, 1843. At King's College School, where his contemporaries included Prof. Saintsbury and the late Dr. Henry Trimen, Dyer was first mathematical scholar: as schoolboys Trimen and he were companions on botanical excursions near London. Matriculating in the University of London, Dyer entered King's College, meaning, like Trimen, to study medicine: in Dyer's case the intention only went far enough to qualify him for eventual admission to the Society of Apothecaries as a 'member by apprenticeship.' At King's College his contemporaries included Sir Charles Lyall, whose participation in Dyer's botanical pursuits made them companions in a vacation walking tour, and provided Lyall in after life with relaxation from the tasks of an Indian official and the studies of an Oriental scholar. This friendship, and the fact that relatives of his father were resident in Madras, while his maternal uncle, T. A. C. Firminger, author of the classic "Manual of Gardening in India," was a chaplain in Bengal, may have induced the idea of an Indian career under which Dyer, at twenty, went up to Christ Church, Oxford, as a Junior Student whose mathematical aptitude and classical proficiency had left unimpaired his early botanical interests.

At Oxford, where Dyer took his degree in mathematics, any thoughts of an Indian career disappeared. He came under the influence of Profs. Rolleston and Daubeny, and formed intimate friendships with his contemporary Prof. H. N. Moseley and their junior, Sir Ray Lankester, who migrated from Cambridge to Christ Church in 1866. His friend Trimen, who had graduated as M.B. London in 1865, at once adopted a botanical career, and in 1866, Dyer collaborated with him in the preparation of their "Flora of Middlesex," which was published in 1869. In 1867, Dyer obtained a first class in the Oxford final Natural History School, and in 1868 became professor of natural history in the Royal Agricultural College, Cirencester. Here he found in Dr. A. H. Church, professor of chemistry, a colleague on whom the influence of Daubeny had also been marked. Impressed by the Yale text-book, "How Crops Grow," Dyer assisted Church to prepare an authorised edition of Prof. S. H. Johnson's work, adapted to English conditions, which appeared in 1869. In 1870, Dyer graduated as B.Sc. London, and was appointed professor of botany in the Royal College of Science, Ireland. Early in 1872 he was again in London: on Jan. 17 he was appointed professor of botany to the Royal Horticultural Society, and assumed office on Feb. 13. Two days later he was elected a fellow of the Linnean Society.

While working for the Horticultural Society at Chiswick and South Kensington, Dyer gave assistance to the director of Kew, the delegates of the Clarendon Press, and the professor of biology in the Royal College of Science. His work at Chiswick included plant identification. This entailed contact with Kew, and brought him an invitation to assist in preparing the "Flora of British India," the first part of which appeared in May 1872. By 1873, Dyer had described the Indian species of six natural families of flowering plants: his contribution, which includes an emendation of the "Genera Plantarum" of Bentham and Hooker, was issued in January 1874. The Clarendon Press had undertaken to publish an English edition of a 'Text-book of Botany' by Prof. Sachs: Mr. A. W. Bennett was employed to translate, Dyer was engaged to edit this work, which was published in 1874. The transfer of the School of Mines from Jermyn Street to South Kensington enabled Prof. Huxley to initiate his laboratory course of biological instruction. Dyer became one of Huxley's demonstrators, and was left to organise and conduct the botanical part of the course, which began on June 24, 1873, and was much appreciated: in May 1874 he was elected to the Council of the Linnean Society.

When Dr. J. D. Hooker became director of Kew in 1865, the assistant-directorship he had held during 1855–65 was suppressed. In 1875 the assistant-directorship was revived: Hooker was asked to select an incumbent. That year Dyer began his share of Huxley's course on Mar. 6: on June 16 he informed the Horticultural Society that he had been appointed assistant-director of Kew, and resigned their service. Dyer's duties under Hooker at Kew did not deprive Huxley of his help at South Kensington; in 1876, Dyer's South Kensington course opened on June 24; in 1880 it began on July 7.

Hooker assigned to Dyer, as assistant-director, the conduct of the colonial activities of Kew: almost the first of his tasks was to have historic consequences. It was thanks to Dyer that in the autumn of 1875, Peradeniya received the young *Hevea* plants, the progeny of which now stocks the rubber plantations of Ceylon and Malaya. It was Dyer who in 1880 sent his friend Trimen, then director of the Peradeniya garden, the selected varieties of Cacao from Trinidad still grown in Ceylon. When, in 1877, Dyer became Hooker's son-in-law, he was given charge of a laboratory for original investigation by workers of any nationality, erected at Kew by a private donor in 1876: under Dyer's management it became, in American judgment, "the best botanical laboratory in Europe." When, in 1882, another private benefaction gave Kew a rock-garden, its design and construction were entrusted to Dyer. In 1880, Dyer's work for Huxley at South Kensington secured his election to the Royal Society: his work for the Colonial Office was recognised by his being created C.M.G. in 1882. In 1884 he was again elected to the Council of the Linnean Society; in 1885, when Hooker retired, Dyer was appointed director of Kew.

As director Dyer at first experienced many calls on his time. He served as vice-president of the Linnean Society, 1885–87; on the Council of the Royal Society, 1886–88; as vice-president of the

Horticultural Society, 1887–89; as a fellow of the University of London, 1887–90. He now resolved to avoid such distractions from official duty, carrying his resolution so far as to decline nomination as president of the British Association; the only exception to his self-imposed rule of 1890 was his service as vice-president of the Royal Society in 1896–97. This rule could not apply to official commands: he had served as a Royal Commissioner for the Melbourne Centennial Exhibition in 1888; he served in the same capacity for the Paris International Exhibition in 1900, and for the St. Louis Exhibition in 1904. Nor did he decline service on committees appointed by the Royal and other societies to deal with specific matters of public importance. Perhaps his most valuable work of this kind was that connected with the Chelsea Physic Garden. As a member of the Corporation to which, since 1673, the Chelsea Garden belonged, and as director of the younger sister institution that public apathy in 1837 had placed in equal jeopardy, Dyer took the initiative in the movement which in 1899 saved the Chelsea Garden from impending destruction.

The intercourse between Kew and India of 1778–1815 was renewed when Kew became a national institution in 1841. Though India Office councillors and secretaries were but rarely botanists like Dyer's friend Lyall, they were usually acquainted with India and its peoples, and could appreciate the bearing of the work at Kew on economic questions with which they were familiar. This intercourse Dyer maintained: in 1892 he was created a C.I.E. As assistant-director, Dyer had induced a similar appreciation of Kew at the Colonial Office, where personal knowledge of our many tropical possessions was necessarily less general. As director, Dyer was now consulted as regards policy. The advice he gave was simple and effective. From 1887 onwards colonial administrators copied the course followed by the East India Company from 1778 onwards. Botanic stations were set up, under competent curators in direct correspondence with Kew: to assist these stations Dyer in 1887 founded the *Kew Bulletin*. The success of this policy was explained to the House of Commons by the Colonial Secretary on Aug. 2, 1898: in 1899, Dyer was created K.C.M.G. The satisfaction felt by overseas correspondents of Kew was shared by Christ Church: Dyer was elected an honorary Senior Student. But a sacrifice was exacted. The assistant-director of Kew, Dr. D. Morris, became Imperial Commissioner, West Indian Agricultural Department: history repeated itself; the assistant-directorship again fell into abeyance.

Though it has been remarked that Dyer's success was largely due to "his intense feeling for the living plant," he realised that without a herbarium a botanic garden is like a rudderless ship: he described the Dipterocarps of India for Hooker the year he organised the botanical portion of Huxley's course. Dyer saw the Kew herbarium extended in 1877, and had to double it himself in 1902. As director he inherited the botanical survey of our overseas possessions undertaken by the elder Hooker at the request of Government. A flora of South Africa, begun in 1859, was suspended in 1865; one of Australia, begun in 1863, was completed in 1878. A flora of tropical Africa, begun in 1868, was suspended in 1877; that of British India, begun in 1872, was still in progress in 1885. Dyer devoted the herbarium resources to furthering the Indian flora; only with the end in sight did Dyer resume the flora of South Africa in 1896; only when the Indian work was completed in 1897 did he resume the flora of tropical Africa. Dyer's competence as a descriptive botanist made him a perfect editor: abstaining from personal contribution to the text of either flora, he was able to edit both.

Dyer obtained relief, when he persuaded his friend, Dr. D. H. Scott, to assume honorary keepership of the Jodrell laboratory, which enabled him to reorganise the museum collections; to improve the lecture course for young gardeners; and to convert into a corps the groups of uniformed attendants at Kew on whose efficiency and courtesy the safety of the collections and the comfort of visitors depend. With the interests of this corps he associated himself; he made it a personal charge, and wore the uniform of its inspector.

Dyer's "intense feeling for the living plant" was shown in 1887 when he provided an Alpine house as an annex to the rock garden; was apparent in the energy with which he replaced outworn conservatories and modernised plant-houses structurally sound; and was especially manifest in his work on the outdoor collections. What Dyer accomplished is best appreciated by those who realise that Kew owes to Sir William Hooker, director 1841–65, its salient features such as the lake and the great vistas; that it owes to Sir Joseph Hooker, director 1865–85, the condition and arrangement of the collections of hardy trees and shrubs, as well as the avenues in the arboretum and the paths in the pleasure grounds that make the collections accessible. Dyer brought to bear on what his predecessors had provided, the care and skill of an artist able to produce landscape effects that "should be suave and ample." Again his method was simple and his success striking. Without any sacrifice of scientific interest he gave access to the glades, and laid open the informal vistas that induce at Kew a sense of space and bring into view objects that attract attention.

In 1899 the winter-garden, left unfinished since 1862, was completed: a Secretary of State indebted to Kew for scientific assistance had secured, in 1894, the review of a decision with which, for a generation, the public department in charge of the gardens had concurred. That department, admirably qualified to administer Kew as a place of public resort, now strove to control the official correspondence of Kew as a scientific centre. The difficulty as regards the department chiefly concerned was overcome when Dyer, in 1902, was appointed botanical adviser to the Secretary of State for the Colonies. To obviate its recurrence, Kew was transferred in 1903 for administrative purposes to a new department, sympathetic with the scientific activities of Kew, but without

experience as regards places of public resort: in 1905, Dyer retired from Kew, but retained his Colonial Office appointment until 1906.

At Witcombe, in Gloucestershire, where Dyer now settled, he took for a decade an active part in the business of the county, for which he became a justice of the peace. In 1908 he was appointed the representative for the University of Oxford on the County Education Committee, and in 1909 became a member of the Court of the University of Bristol. On behalf of Kew he continued to edit the "Flora of Tropical Africa" until 1913, and the "Flora Capensis" until it was completed. Meanwhile at Oxford it had not been forgotten that Dyer was a scholar as well as a biologist, to whom, in both capacities, Daubeny had imparted his own keen interest in the identity of classical plants: Dyer undertook to assist those engaged in revising the lexicon of Liddell and Scott. In 1916, Dyer reviewed his obligations much as he had done in 1890, and, as a result, resigned a position in the Royal Horticultural Society, to which he had been appointed when Hooker died in 1911; relinquished the seat on the County Education Committee which he had occupied since 1908; left the Athenæum, to which he was elected 'by the Committee' in 1885; and retired from the Royal Society. His work for the editors of the new Liddell and Scott had involved much careful investigation: from 1916 until his death on Dec. 23, 1928, Dyer's time, when health permitted, was largely spent in continuing his classical studies, and amassing material for a glossary of ancient plant names.

Transparent honesty of purpose and rigid accuracy of statement were, in the case of Dyer, associated with clear vision, firm decision, and prompt action. Direct in speech and incisive in style, his intention could never be mistaken. To these qualities, which made him a wise adviser and a faithful friend, were added a mine of knowledge and a width of culture, that made social intercourse with him an intellectual feast. With these qualities, that were attractive, were associated two habits that, though only defects of his merits, at times interfered with his influence as a man of affairs. His instinctive dislike of ambiguity, which included aversion to any attempt at compromise of principle, induced a habit of which he was conscious, that endeared him to correspondents abroad, but was disconcerting to colleagues in Great Britain. The other habit, of which he was evidently unconscious, caused him to wound the susceptibilities of many of those whose views he found himself unable to accept. To this latter habit may be attributed Dyer's failure to find support for proposals that, when afterwards submitted by others, were accepted without debate. In his choice of men Dyer paid more regard to character, of which he was only a tolerable judge, than to capacity, in the assessment of which he was singularly successful.

The type of botanical teaching of which Dyer was the pioneer in Britain has induced an academic impression against which Dyer's administrative activities were an eloquent though silent protest: to that impression we owe the modification of his colonial policy. Dyer's work for Kew will survive long after his precise share therein has been forgotten. Should it prove possible to make available the fruits of the labours of his later years, it may be that in these will be found an even greater claim to grateful remembrance. As it is, Dyer has placed mankind under two important obligations. His manhood was given to teaching science that the improvement of natural knowledge for use is a service as honourable as the improvement of natural knowledge for discovery: he used the leisure of his later years in reminding letters that the interest of science in the 'humanities' may be as great as that of scholarship. Both are lessons still badly needed.

THE story of Thiselton-Dyer's life as related above by another contributor is only half told if his wide knowledge of ancient botany and of classical literature be not recorded and appraised; for besides being an eminent botanist and a first-class man of affairs, he was a scholar of wide reading and meticulous accuracy.

Sooner or later men come back to what they loved as boys; and Dyer told me once that Martyn's "Georgicks" had been his favourite school-book. John Martyn, F.R.S., was professor of botany in Cambridge in the middle of the eighteenth century; his two books, one an edition of the "Georgicks," the other of the "Bucolicks," were school-books for a hundred years, and it is a pity that they are used no more. The very pictures in Martyn were delightful: the olive-tree and the 'hyacinth,' the *cerinthæ ignobile gramen* beloved of bees, the *flos in pratis cui nomen amello*, the figure and description of Virgil's plough, and the picture of the northern heavens with the Dragon winding like a river between the Great and Little Bears—one remembers them all. In the botanical chapter which Dyer wrote for Sir John Sandys' "Companion to Latin Studies," while nothing of moment is left out, yet Virgil always has the middle of the stage; and Martyn's two books head the long list of quoted authorities. Dyer was always fond of old books, and liked (as he said) to "take stock of the harvest of accurate and acute observation to be found in the writings of authors now almost fallen into oblivion, yet long recognised as classical." He bought a Clarke's Odyssey for half a crown when he was a schoolboy, in a small book-shop, "a mere open booth, in the purlieus of Leicester Square"; and he used it to the last, because it "gave the comments of Eustathius, which no modern editor will look at."

Thiselton-Dyer took his degree at Oxford in mathematics, a fact which I have not seen mentioned; he was proud of it, and prouder still that he had been a pupil of Henry Smith's. "Is it not recorded" (he says in one of his letters to me) "in the preface to the Cambridge edition of his works? *That* I think earned me more respect from L . . . r than he would have bestowed on what Augustine Birrell called a 'mere botanist.'"

Thiselton-Dyer's classical papers are few in number and represent imperfectly his vast stores

of knowledge. His unrivalled knowledge of Greek plant-names he gave freely to the new edition of Liddell and Scott, regretting all the while that much useful and appropriate matter, the great mass of his accumulated notes, could find no place therein. He knew, as many another scholar knows, that what we wanted was no mere Lexicon but a "Thesaurus," and that England should have been rich and generous enough to let her scholars make one. But Liddell and Scott held the field and "queered the pitch," he said; and though he loved the great book, all the more because it hailed from his own College, he spoke of it as "So-and-so's dry-as-dust pemmican,—if you can conceive the similitude."

Apart from his contributions to the Lexicon and his two chapters in the Companions to Latin and Greek Studies, Thiselton-Dyer's chief writings on classical botany are found in the *Journal of Philology*, now dead, which flourished under the editorship of Ingram Bywater and Henry Jackson. Dyer wrote at least three papers for that journal, these three including articles on about thirty "Ancient Plant-names," all more or less obscure and difficult. One of the smaller articles (by way of example) was on the ἐλαίαγνος, a plant mentioned by Theophrastus, which the old Liddell and Scott called "a Bœotian marsh-plant, perhaps *myrica* or *sweet-gale*." Dyer had no difficulty in showing that it was not *myrica*, which means tamarisk, nor was it sweet-gale, which is a northern plant unknown in Greece. He showed in the end that the word were better written ἐλέαγνος, which is plain Greek for a marsh-lambkin; and that Theophrastus's plant was nothing but the common goat-willow, *Salix caprea*, whose catkins country-folk still call "lambs' tails." For a more elaborate essay take the one on *Amomum*, a very difficult word, which Thiselton-Dyer traced up and down through an immense field of old literature. He begins by showing, from Theophrastus, how both Amomum and Cardamomum came from India; and how when Pliny and Dioscorides call them natives of Media, Pontus, and Armenia, these are but the trade-routes by which they came. Pliny's Cardamomum is easily disposed of; it is the common Malabar Cardamom of the apothecaries. Amomum is much more difficult; but Dyer shows how Pliny's description of it as a shrub (*frutex*), growing on the mountains (*montuosus*); with its spiny inflorescence on a short stalk (*palmi altitudine*); with its scaly leaves or bracts "like those of a Pomegranate," which soon turn dry and brittle (*posterius fragile*), and need to be gently handled and kept together (*manipulatim leniter componi*),—how all this tallies word for word with the Nepaul Cardamom (*A. subulatum*) of the Himalayan slopes, still used in India as a cheap substitute for the real thing. He then discovers the very same identification in the rare "Commentatio de Amomo" of Nicolo Maragna, a Veronese physician, whom Caspar Bauhin quotes in his "Pinax." Lastly, he proceeds to discuss, carefully and patiently, the uncertain source and difficult etymology of the word.

No busy and laborious man ever finishes his life's work, no good man reaps all the harvest he has sown. But it is earnestly to be hoped that what Thiselton-Dyer has left behind, ungarnered and unpublished, may see the light of day. Just eight years ago he wrote me: "I have projected a Glossary [of classical Plant-names], and the Clarendon Press profess to be willing to print it. I have the whole thing in slips, and I go on annotating. . . . But whether with impaired health I shall be able to accomplish a fair copy for the printer is a problem." A sympathetic and friendly biographer said the other day that Thiselton-Dyer would be "remembered as a great botanical administrator." Even such qualities as he possessed and such services as he rendered in this capacity will, I think, prove less memorable than the scholar's task which was the pastime of his busy life and the occupation of his later years. D. W. T.

Dr. S. J. Mauchly.

Sebastian Jacob Mauchly, physicist with the Department of Terrestrial Magnetism of the Carnegie Institution of Washington since 1914, died on Dec. 24, at his home in Chevy Chase, Maryland, after a long illness. Dr. Mauchly, who was fifty years of age, specialised in terrestrial electricity, and as chief of the Section of Terrestrial Electricity of the Department was responsible for the development and improvement of many instruments for observing the electric elements at field and observatory stations. He made numerous valuable contributions to this branch of science and was the first to direct attention to the apparent universal twenty-four hour term in the diurnal variation of the earth's electric field. This fundamental result was deduced by him largely from his discussions of the work at sea by the *Carnegie*, and he later corroborated this conclusion by extensive investigations of results at land stations over the entire globe. He was also chief of the solar eclipse expedition of the Carnegie Institution of Washington to Lakin, Kansas, in 1918, and co-author of Vol. 5 of Researches of the Department of Terrestrial Magnetism, 1926.

Dr. Mauchly received his educational training at the University of Cincinnati, where in the Department of Physics he took the degree of A.B. in 1911, and as Hanna research fellow, that of Ph.D. in 1913. He was a fellow of the American Physical Society and the American Association for the Advancement of Science, and a member of the American Geophysical Union, International Geophysical Union, Washington Academy of Sciences (serving on the board of editors of the *Journal*, 1925–26), and of the Washington Philosophical Society (recording secretary 1919–21).

We regret to announce the following deaths:

Mr. Bernard Coventry, C.I.E., first director and principal of the Agricultural Research Institute and College, Pusa, Behar, on Jan. 26, aged sixty-nine years.

Prof. Johannes von Kries, of Freiburg im Breisgau, the distinguished physiologist and editor of the third German edition of Helmholtz's "Physiological Optics," on Dec. 30, aged seventy-five years.

News and Views.

SIR ALFRED EWING'S intimation that he desires to retire from the principalship of the University of Edinburgh on Sept. 30 came as a great surprise to his colleagues. He refers in his letter to the University Court to the fact that in a few weeks he will be seventy-four years of age, but his friends have noted no sign of failing in his wide scientific outlook or in his grasp of the business of the University. Since 1916, when Sir Alfred was offered and accepted the principalship in succession to the late Sir William Turner, the University has expanded greatly—thirteen new chairs have been founded. Especially noteworthy is the acquisition of a site of 115 acres on the southern edge of the city, on which now stand the departments of chemistry and geology, and on which the new departments of zoology and animal breeding are in course of erection. Other extensions include the purchase of premises near the Old College for English and modern languages, the reconstruction of the Department of Surgery and the building of a laboratory for clinical medicine at the Royal Infirmary. Early in his tenure of office Sir Alfred successfully carried through the negotiations which resulted in the admission of women to full privileges as students in the Faculty of Medicine, and later he brought into closer co-operation with the University the Training College for Teachers and the Edinburgh and East of Scotland College of Agriculture, the heads of which are professors in the University. Sir Alfred has shown himself throughout to be a man of great energy and resource. He has never spared himself when he could serve the University, and he has done much to bring about a better understanding between the University and the city. It was entirely fitting, therefore, that at a meeting of the Lord Provost's Committee, held on the day on which Sir Alfred's resignation was announced, it was unanimously resolved to recommend that the freedom of the city be conferred upon him.

THE paper read by Mr. G. Fletcher at the Royal Society of Arts on Wednesday, Jan. 30, on the Shannon hydro-electric scheme, attracted a very large audience. It will be remembered that four years ago the Irish Free State decided to undertake an ambitious scheme for supplying hydro-electric power to Ireland. The scheme was devised by an eminent firm of German electrical engineers, and after being slightly modified by a committee of four continental experts, who spent a few weeks making a local study of the problem, was adopted, the whole undertaking being at the expense of the Government. Provision was made not only for the existing needs of a large part of the country, but also for the needs of industries which it is hoped will be established when power is available. Next October the first stage of the scheme is to be completed, the expense up to this stage being about five million pounds.

THERE are about 130 towns and villages in the area of supply of the Shannon hydro-electric scheme which have not an electric supply. It is proposed to charge consumers on the basis of 2*d.* per unit and an additional charge varying from 6*d.* to half-a-crown per week, depending on their Poor-law valuation. For small houses the wiring will be done on the hire-purchase system, a fixed weekly charge being made until the cost has been refunded. Public institutions and factories will be charged 6d. per unit for lighting. As Dublin has a very active and efficient municipal supply by steam generating plant, it is difficult to see how it can benefit from the Shannon scheme. The annual cost of the interest and the power losses in the 'grid' to Dublin from the Shannon power house will be very appreciable. Whilst it is easy to criticise the scheme from the business point of view, the new power station when finished will be a valuable asset. Every effort must be made to attract industries requiring electric power to Ireland. The danger lies in political pressure leading to a rapid expansion of the grid unjustified by the demand and to the scrapping of profitable steam undertakings.

A NUMBER of papers dealing with band spectra have appeared recently in the *Proceedings of the Royal Society*. Following on the investigations of Lord Rayleigh on mercury, and of Prof. W. E. Curtis and Dr. Jevons on helium, and of Sir Robert Robertson on ammonia, phosphine, and arsine, to mention only a few of the more important that were published last year, there is now a group of six communications by various authors in the first number of the *Proceedings* for 1929. One of these, by Dr. Kapuscinski and Miss Eymers, on intensity measurements in the secondary spectrum of hydrogen, is purely descriptive, although it constitutes a valuable appendix to the wave-length tables of this spectrum which were recently issued from Bonn, and provides rich material for its further analysis. The other papers all deal with problems of molecular structure, and include independent contributions by Dr. R. C. Johnson and Dr. Jevons on the spectra of certain fluorides, a paper by F. A. Jenkins and H. A. de Lazlo on the celebrated bands of silicon nitride, and one by J. M. Walter and S. Barratt on the band spectra associated with the vapours of zinc, cadmium, and mercury.

THE main interest of band spectra appears now to have shifted to the problems which have been raised by the new mechanics, and to the elucidation of the nature of the electronic transitions involved in the production of bands in the visible and ultra-violet regions. In cases where a definite decision is possible, the new quantum theory, here as elsewhere, predicts results which are in better agreement with experiment than those which would follow from the older quantum theory ; in the matter of electronic energy levels, there can also be little doubt that the theories which are being developed by Dr. Hund in Germany and by Prof. Mulliken in America, to which several references have been made in NATURE, are essentially correct, although there still remains a great deal to be done in this connexion. It is unfortunate that very many

substances which give rise to well-developed band-spectra cannot be isolated as chemical individuals; there seems to be no immediate prospect of obtaining molecular helium outside of a discharge tube, for example, and even the fluorides which were mentioned above are probably chemically unstable or unimportant compounds. Hydrogen and carbon monoxide are two notable exceptions *inter alia*, and in such cases identity of the molecular constants deduced from the band spectra and from physico-chemical data respectively provides a valuable test of the theoretical interpretations of both sets of measurements.

CABLE advices from the *Carnegie* after her arrival at Callao on Jan. 14 state that on Jan. 8 a new submarine ridge, which has been named Merriam Ridge, was discovered. At the point of crossing, Merriam Ridge is ten miles wide and rises 3000 metres above the 4000-metre depth on either side. The top of the ridge, in lat. 24° 57′ S., long. 82° 15′ W., is at 1168 metres, this value being checked by three sounding methods, namely, sonic, wire, and thermometer, to within 20 metres. When 60 miles west of Callao, the surface temperature, which had been 21·5° C., dropped to 19° C. and remained at that value until arrival at Callao. Captain Ault's report shows that the activities in the various observational programmes are being successfully continued, the work between Easter Island and Callao (Dec. 12, 1928–Jan. 14, 1929) including 38 declination stations, 15 horizontal-intensity and inclination stations, 17 oceanographic stations, 72 sonic depth stations, 12 pilot balloon flights, 25 complete photographic 24-hour potential-gradient records, 4 24-hour series of other atmospheric-electric observations, 20 biological stations, 6 evaporation series. The vessel was expected to leave Callao about Feb. 3 en route to Papeete, Tahiti, Society Islands, where she is due to arrive early in March.

PRIOR to the War, all the medical schools of the University of London (with the exception of the London School of Medicine for Women) were restricted to men, but it will be remembered that during the War seven of the schools admitted women in addition. These facilities for women were withdrawn a short time ago, except in the case of University College Hospital, which still admits a limited quota. The action of the authorities of the medical schools aroused considerable discussion, and a Committee was appointed by the Senate of the University of London "to consider the question of the Limitations placed upon the Medical Education of Women Undergraduates." According to the report which has just been issued, it is considered that the facilities in London for *pre-clinical* instruction of women are ample, and it is only the withdrawal of those for *clinical* instruction which has given rise to the present inquiry. The Committee thinks that there is no valid argument against the provision of co-education, but that co-education to be successful must be voluntary. No countenance is therefore given to the suggestion which has been made that the University should enforce a policy of co-education upon the medical (and other) schools by withdrawal of recognition or other means. Such a policy, to be logical, would have to be applied all round, and this would force men upon women's colleges, and men upon the London School of Medicine for Women! Nor does it seem desirable that co-education should be universal in the medical schools of London, for such a policy might result that in some schools there would be only a very small number of women—possibly only one woman—which on various grounds is highly undesirable. The Committee recommends, therefore, and the Senate has given general approval, that its report be communicated to the schools in the Faculty of Medicine, and that the vice-chancellor be requested to invite them to consider the possibility of admitting a quota of women students in the future.

THE Joint Expedition of the Percy Sladen Memorial Fund and the American School of Prehistoric Research, which has recently been investigating caves in the Sulaimani district of north-east Iraq, has discovered Palæolithic remains in two of the sites in which soundings were made. A small cave near Zarzi, about 30 miles north-west of Sulaimani, which was excavated completely, yielded an abundant late Upper Palæolithic industry which has marked affinities with the Upper Aurignacian of Central Europe and of the Grotte des Enfants at Mentone. The presence of Tardenoisian microliths in the upper part of the deposit shows that this industry, although typologically Aurignacian, represents the final development of the Upper Palæolithic in a region into which the Magdalenian never penetrated. The second Palæolithic site discovered was near Hazar Merd, 10 miles due west of Sulaimani. A large cave known locally as the 'Dark Cave' (*Ashkot-i-Tarik*) contained Mousterian hearths three metres in thickness, underlying a mixed layer with pottery of various ages. The Mousterian industry is true to type, and contains no elements that are not already well known in the Mousterian of Europe. It is marked by an abundance of well-made points and a relative scarcity of side-scrapers. Owing to its size the 'Dark Cave' could only be partially excavated, but it is hoped that the American School of Prehistoric Research will be able to complete the work next season. These are the first recorded Palæolithic finds in southern Kurdistan, but there is no doubt that the whole area is rich in promise, and the comparatively settled state of the country should now make it possible to carry on work in this region, which for many years has been practically closed to Europeans.

THE executive committee of the Cambridge Preservation Society, which was formed in March of last year, has published a short statement of a particular part of its work during the past year. It was felt that at all costs the pleasant road to Madingley, the view from Madingley Hill and the approach to Coton village by the footpath should be secured. Finding that the risk was acute, it was decided to use whatever funds were available to this end. Assisted by Col. ffennell of Whytham, near Oxford, Prof. Trevelyan, and other benefactors, the Society was enabled to purchase for £22,300 about 380 acres of land, including the south side of Madingley Hill. The danger to a most beloved part of the countryside west of Cambridge has thus

been averted for the time, but by the acquisition of this land the Society has incurred a considerable debt. The generous benefactors who have lent money must be repaid, and it is certain that further help will be required. The Society intends, however, to postpone to a later date any public appeal for funds in order not to interfere with the efforts of the University to raise money for meeting the conditions of the recent benefaction from the International Education Board.

AMONG the many scientific investigations being made into food storage and preservation are those relating to the handling and carriage of fruits to Great Britain from various parts of the Empire, and every fruiterer's shop in London is evidence of the value of those investigations. Few people, however, realise the extent of our fresh-fruit trade with Australia and South Africa, the latter of which exports annually 27,000 tons of soft fruits such as grapes, pears, and peaches, and 45,000 tons of citrus fruit, principally oranges. A few years back, such fruits were placed directly in the refrigerated holds of ships and much waste occurred. To-day, all the fruit is pre-cooled before shipment, and *Engineering* for Jan. 25 contains a description of the buildings and methods used at Cape Town for this purpose. Fruit on arrival by train is run into a large insulated air-lock, unloaded on to standard-size trolleys and then electrically hoisted and traversed into cooling chambers, of which there are 72, each capable of holding 12 trolleys. Soft summer fruits such as grapes and peaches are then cooled from 90° to 34° F., while winter fruits have to be cooled from a temperature of about 60° to 40° F. In shipping, the trolleys are run out and hoisted directly aboard. Many problems of construction, refrigeration, and insulation were involved in the design of the building and machinery, the consulting engineer for which was Mr. E. A. Griffiths, physicist to the South African Government.

SIR WILLIAM BRAGG delivered the first of a course of three lectures at the Royal Institution on "The Early History of X-Rays" on Jan. 31. Sir William stated that no scientific discovery before or since that of Röntgen in 1895 has excited such immediate or universal interest. The effect was all the greater because scientific workers everywhere were able to repeat the experiment without difficulty. From a scientific point of view the new departure was equally remarkable. As Maxwell pointed out long ago, the problem of the relation between electricity and matter was more likely to receive explanation from the study of the electric spark than in any other way, but the key had not been found in 1895. Röntgen's discovery so increased the facilities for experiment, and was so suggestive of the directions in which to move, that the world was soon led to the recognition of the electron as the all-important factor. Before 1895 the wealth of experimental results lacked co-ordination. The work of Faraday had shown that molecules in a liquid were broken into parts of which some carrying negative electricity moved towards the negative and others towards the positive pole. But the puzzle was as to why it was so easy to send the current through the liquid and so difficult to send it through a gas. Yet in certain circumstances, such as heating by a flame or the action of ultra-violet light, a gas could be made to conduct quite well. It became clear that the molecules of the gas must be broken before the electricity could pass, just as in a liquid. The knowledge of the fact that the atom was not the unchangeable entity which it had been assumed to be, and that an electron could be torn from it and become free to move and shatter other atoms, was still hidden from the experimenter, and it was this which caused all his results to lack cohesion. But he could at once appreciate the new discovery and move on towards the explanations that were forthcoming almost immediately.

AT a meeting of the Newcomen Society on Jan. 23, Mr. Rhys Jenkin read a paper entitled "A Chapter in the History of the Water Supply of London," in which he dealt mainly with the pumping apparatus erected by Sir Edward Ford on the banks of the Thames a little to the east of Somerset House. Ford, who was born in 1605 and died in 1670, was a royalist soldier of good family and married the sister of Ireton, son-in-law of Cromwell. During the Commonwealth he turned his attention to practical invention, and in 1655 was granted a patent for a pumping apparatus. The patent is not merely of interest in the history of mechanics, but also it was one of only about a dozen such patents granted by Cromwell, and it is the only one the enrolment of which is to be found at the Public Record Office. The machinery, which was horse worked, was in a tower and, according to the description contained in the *Journal des Voyages de Monsieur de Conconys*, published in 1666, it consisted of four suction pumps in series worked by levers and rods moved by a cam wheel turned by the horses. The tower is shown in a contemporary plan of the district by Hollar. Ford's pumping engine was one of several which were erected on the Thames between Chelsea and Wapping in the seventeenth century.

PARTICULARS of America's longest railway tunnel were recently given in a *Daily Science News Bulletin* published by Science Service, Washington, D.C. The tunnel is on the Great Northern Railway, and pierces the Cascade Range of mountains about a hundred miles east of Seattle. Up to now, the longest railway tunnel in America was the Moffatt tunnel in Colorado, 6·11 miles long. The Cascade tunnel is 8 miles long, and is said to be exceeded in length by only the St. Gothard, Simplon, Loetschberg, and Mt. Cenis tunnels through the Alps. Another very long tunnel, however, is the Apennine Tunnel on the Apulian Aqueduct in southern Italy. This is about 9½ miles long. In constructing the Cascade tunnel, advantage was taken of the existence of a deep valley over the projected line, and from this a shaft more than 600 feet deep was sunk. From this shaft auxiliary tunnels were bored east and west, and these again were used to give access to several working faces in the main tunnel. By this means, progress was so rapid that the work was carried through in three years. The tunnel was open for traffic on Jan. 12, trains being worked through by powerful electric locomotives supplied with current at 11,000 volts.

ACCORDING to the Report of the Building Research Board for the year 1927 (London: H.M. Stationery Office; 3*s*. net), which has recently appeared, the staff of the Board at the end of the year was 111, and committees on weathering, on structures and on acoustics, assist the Board. The work in progress deals with weathering, building materials, cements, plasters, asphalts, with wind pressure and vibrations, and with heating, ventilation, and acoustics of buildings. The sulphuric acid from coal fires appears to be greatly responsible for weathering, and capillary effects for the decay of sandstone in the vicinity of limestone. Thermal stresses due to unequal temperature or to freezing cause spalling. Washing a surface at intervals and plastic repairs with oxychloride cement retard decay. The tests of structures show that their strength cannot be predicted from that of the bricks of which they are composed. Although results of such importance as these are being obtained and are made public by reports and by articles in the technical and the daily Press, the Board feels that full advantage is not being taken of the information by the industry. Closer co-operation between the Board and the industry is much to be desired.

THE nature of the work done by research associations does not as a rule lead to immediate and sensational achievements. It does, however, often lead to considerable improvements in manufacture and consequent reductions of price. To take a concrete case, the British Electrical and Allied Industries Research Association, which has just issued its eighth annual report, points out that its researches on cables have led to very appreciable economies being effected in the distribution of electrical energy. The consumer gets part of this saving as the price of supply is reduced. Similarly, the researches on the properties of steam which Prof. H. L. Callendar carried out for the Association will probably result in improvements in the manufacture of steam turbines, and again the public will get part of the benefit. The Association spent last year £25,000, of which the Government contributed £7200. This grant will rapidly diminish as the end of the second five years of the existence of the Association approaches, and it is necessary to take immediate action. At present the manufacturing section of the industry provides the larger part of the cost and eighty per cent of the personnel of the numerous technical committees. It has been pointed out that if every consumer of electrical energy contributed one farthing for each pound paid for electrical energy consumed, then the sum provided would pay for the whole annual cost of the researches of the Association, and the consumer would doubtless reap the benefit. We are afraid, however, the procedure underlying this suggestion could not be generalised and applied to researches in other directions. It would, therefore, even if it were equitable, be impossible to put directly into practice.

TWO recent communications, one to the Manchester Literary and Philosophical Society, by Mr. H. Garnett, and another to the International Photographic Conference, have directed attention to the work of John Benjamin Dancer, one of that numerous class of scientific worthies whose names remain almost unknown, while their work is the property of all. Who, for example, knows that Dancer was the inventor of the porous earthen pot used in millions of 'wet' batteries? Who remembers that he devised the spring contact breaker or current interrupter originally applied to the induction coil, and still employed in almost the same form in every electric bell throughout the world? He was also the inventor of the minute photographs on glass which attracted attention at one time; he was one of the earliest workers on the form of photography introduced by Daguerre; and he experimented on the electro-deposition of copper. Another of his inventions was the binocular stereoscopic camera, the original example of which is preserved at Manchester and was described to the International Photographic Conference last summer. Like his father and grandfather, an optician by calling, Dancer made all the apparatus used by Joule in his classical experiments on the mechanical theory of heat. Born in London in 1812, he died in straitened circumstances in Manchester on Nov. 22, 1887, having for many years been blind.

THE Royal Cornwall Polytechnic Society was founded in 1833 at the suggestion of Miss Anna Maria Fox, its first purpose being to encourage a number of clever workmen who spent their spare time in constructing models and devising inventions. It set itself to provide technical education, and to encourage industry and ingenuity in a community distinguished for its mechanical skill, as well as to finance any invention likely to benefit local industries, particularly mining. The short history of the Society, which is included in the annual report for 1927, shows how the meetings became a recognised centre for the exhibition and demonstration of new inventions, some of which have become of world-wide renown and usefulness, such as Were Fox's dipping needle deflector, Nobel's nitro-glycerine, and Loam's man engine. Even more generally important have been the Society's educational efforts. Evening classes in mining subjects, a science school at Falmouth, and classes in connexion with South Kensington examinations, all owe their origin to its foresight and energy. The reports of 1927 and 1928 (vol. 6, pts. 1 and 2) show that the arts and crafts are still being encouraged by extensive prize schemes in connexion with the annual exhibition and special school work. In addition to their formal records, the reports also contain notes on eminent Cornishmen, and original articles on "Ancient Mining in Cornwall," French war prisoners in Cornwall, and the "China Clay Industry," as well as an address by Lord Gainford on "The Progress of Broadcasting."

TWO articles of special biological interest in the December *Scientific Monthly* are Prof. Chas. G. Rogers' "Physiological Evidences of Evolution and Animal Relationship," and Prof. Theodore Korpányi's "Transplantation of Organs." In the former is discussed the possible evolutionary significance of the osmotic pressure of body fluids, their composition, and the relationship between their hydrogen ion concentration and that of sea-water; blood coagulation

and blood reactions; chemical actions and regulations in living bodies; excretion, reproduction, and death. The discussion suggests many physiological lines along which further investigation might well lead to biological conclusions of general importance. Prof. Korpányi's article describes the wonderful success which attended his efforts to transplant organs, such as amphibian and mammal eyes, the testis and spleen of amphibians, the spleen of rats, from their original connexions to entirely novel positions. Even amongst mammalia he has found that in its own proper situation a transplanted eye may regenerate the optic nerve and regain a power of vision.

THE Ossolinski Institute at Leopol (Lwow), in Polish Galicia, has recently celebrated its centenary. The founder died in 1826, his library arrived at Leopol in 1827. The Institute has been an irreducible bastion of Polish culture and intellectual life during a tragic century. The union of Polish learned societies in Leopol now presents a *Bulletin* (in French) describing their activities during 1925 and 1926. There are some thirty associated societies grouped in unions round the six Polish universities. Intellectual life is just emerging from war-time depressions. Books in Polish are a difficulty exaggerated by high costs of printing, import taxes on paper, lack of modern printing machinery, and the discouragement of publishers who find only a restricted market. The suggestion is made that publishers might agree not to publish competitive scientific books with similar contents, also to prepare a programme of educational text-books. Co-operation with foreign countries is welcomed; scientific publications have been sent to Tokyo and received from America, but on the whole it has proved easier to exchange periodicals than personal visits. Visitors to Poland will find the 94 pages of this *Bulletin* a useful vade-mecum as a guide to persons and institutions.

THE Registrar-General has issued the provisional figures of the birth- and death-rates and infantile mortality during 1928 for England and Wales. The birth- and death-rates are respectively 16·7 and 11·7 per 1000 population, and the infantile mortality is 65 deaths under one year per 1000 live births. The birth-rate is 0·1 per 1000 above that of 1927, and the death-rate is 0·6 per 1000 below that of 1927, and only 0·1 per 1000 above the lowest recorded (1923 and 1926). The infantile mortality-rate is the lowest on record, 4 per 1000 births below that of 1923.

DR. J. A. V. BUTLER, lecturer in physical chemistry in the University of Edinburgh, has been awarded the Meldola Medal of the Institute of Chemistry for his published work on the modern theory of conducting solutions. The Meldola Medal is awarded annually to the chemist whose published chemical work shows the most promise, and is brought to the notice of the administrators during the year ending Dec. 31, prior to the award. The recipient must be a British subject of not more than thirty years of age at the time of the completion of the work.

IT is announced in *Science* that Dr. Oliver Kamm, head of the department of chemical research of Parke, Davis and Company, formerly professor of organic chemistry in the University of Illinois, has been awarded the prize of 1000 dollars of the American Association for the Advancement of Science. The prize is awarded each year for a notable contribution to science presented at the annual meeting of the association and the associated scientific societies. Dr. Kamm's paper, presented before the section of chemistry at the recent New York meeting of the Association, was entitled "Hormones from the Pituitary Glands."

ACCORDING to the *Times* of Jan. 31, Signor Mussolini has presented to Switzerland a part of the scientific manuscripts of Albrecht von Haller, which were deposited at the Brera Library in Milan, and in the University of Pavia. Haller has sometimes been called the father of modern physiology. Born at Berne on Oct. 16, 1708, as a boy he acquired knowledge with ease, and as a man displayed immense industry and unusual versatility. His medical studies were prosecuted at Tübingen and at Leyden, where he came under the influence of Boerhaave. He practised for a time in his native town, and from 1736 until 1753 was professor of anatomy and botany at Göttingen. Returning to Berne, he there compiled his "Elementa Physiologiæ" and other works, took part in public affairs, and corresponded with eminent men in all parts of the world. He died at Berne on Dec. 12, 1777.

AT the recent annual meeting of the Botanical Society of America, held in New York City, the following were elected as Corresponding Members: Prof. C. H. M. Flahault, professor of botany in the University of Montpellier; Dr. D. H. Scott, lately honorary keeper of the Jodrell Laboratory, Royal Botanic Gardens, Kew; John I. Briquet, director of the Botanic Gardens, Geneva; and Alexander Zahlbruckner, director of the botanical section of the Natural History Museum, Vienna. The following were elected officers for the Society: *President*, Dr. Margaret C. Ferguson, Wellesley College; *Vice-President*, Dr. L. W. Sharp, Cornell University.

IN our issue of Aug. 18, 1928, p. 251, reference was made to a 'record' low barometric pressure of 665·1 mm. (886·8 millibars) during a typhoon. It should have been stated that the observation was made on Aug. 18, 1927.

THE *Leicester Museum, Art Gallery, and Library Bulletin*, a quarterly leaflet of about eight pages, is a useful means of keeping touch between the public and the institutions. The January number contains a select list of recent additions to the Library, but none of them, out of about a hundred serious volumes on science, art, and philosophy, deals with biological science. The special exhibition illustrating "Sport in the Midlands," from contemporary paintings, drawings, and prints of the last two centuries, proved to be a great success.

THE Ministry of Health has issued to sanitary authorities a *Circular* (No. 955) directing attention to the rapid spread of influenza reported from the United States and Canada, and bringing to the notice of local authorities the Memorandum on Influenza issued in 1927 (Memo. 2/Med.). This memorandum reviews the 1918–19 epidemic, discusses the bacteriology of the disease and mode of infection, and describes measures of personal protection and precautions when attacked, and outlines the action to be taken by sanitary authorities to combat influenza outbreaks. According to a recent *Daily Science News Bulletin*, issued by Science Service of Washington, D.C., more than a million cases of influenza occurred in the United States before Christmas, but the epidemic is now subsiding.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned :—A county librarian under the Leicestershire County Council—The Director of Education, County Education Office, Leicester (Feb. 16). A live stock officer under the Ministry of Agriculture and Fisheries—The Secretary, Ministry of Agriculture and Fisheries, 10 Whitehall Place, S.W.1 (Feb. 18). An assistant chemist under the Northern Coke Research Committee—Prof. Briscoe, Armstrong College, Newcastle-upon-Tyne (Feb. 18). A tutor for philosophy, politics, and economics at St. Hilda's College, Oxford—The Secretary, St. Hilda's College, Oxford (Feb. 23). A lecturer in pharmaceutics at the Chelsea School of Pharmacy—The Principal, Chelsea School of Pharmacy, Chelsea Polytechnic, S.W.3 (Feb. 25). A biologist, and a chemist, with experience of physiological problems, to assist in carrying out a survey of the Estuary of the River Tees—The Director, Marine Biological Laboratory, Plymouth (Feb. 28). A junior scientific officer under the Directorate of Scientific Research of the Air Ministry, primarily for research work in the aerodynamics department of the Royal Aircraft Establishment—The Chief Superintendent, R.A.E., South Farnborough, Hants (Mar. 2, quoting A.319). A head of the engineering department of the Technical Institute, Gillingham—R. L. Wills, Elm House, 15 New Road Avenue, Chatham (Mar. 9). An associate professorship of geography in the University of Sydney—The Agent-General for New South Wales, Australia House, Strand, W.C.2 (Mar. 16). A professor of philosophy in the University of Lucknow—The Registrar, The University, Lucknow, India (Mar. 17). A professor of medicine in the University of Lucknow—The Registrar, The University, Lucknow, India (Mar. 31). An assistant lecturer and demonstrator at the Leathersellers' Technical College—The Acting Principal, Leathersellers' Technical College, 176 Tower Bridge Road, S.E.1. Assistant directorships of a social survey—The Professor of Social Science, University, Liverpool. An entomologist for original research work into the bionomics of Tacchardia Lacca —"India," care of Richardson and Co., 26 King Street, St. James's, S.W.1.

Our Astronomical Column.

A CHART OF MERCURY.—M. E. M. Antoniadi published a chart of Mercury in *Comptes rendus* of the Paris Academy of Sciences in the autumn of 1927. This is reproduced, with a few additions resulting from his 1928 observations, with the 33-inch Meudon refractor, in the *B.A.A. Journal* for January 1929. Some of the markings, in particular those in the north-east quadrant, closely resemble those in Schiaparelli's chart, reproduced in *Ast. Nach.*, 2944 ; but the south-west quadrant is practically filled with a dusky shading ; the darker regions of this coincide with narrow dark markings drawn by Schiaparelli.

M. Antoniadi looks on the 88-day rotation, first announced by Schiaparelli, as completely established. He remarks that it has long been known that Japetus always turns one face to Saturn, this being proved by its notable variation of light in different regions of its orbit ; and as its distance from Saturn is 62 Saturn-radii, it was only to be expected that the sun, the density of which is twice that of Saturn, should produce a like effect on Mercury at a distance of 82 sun-radii. He considers that the axis of rotation of Mercury is not exactly perpendicular to the orbit plane, but does not indicate the amount or the direction of the deviation.

EPHEMERIDES OF VARIABLE STARS.—At the meeting of the International Astronomical Union at Rome in 1922, the Cracow Observatory was entrusted with the calculation and publication of ephemerides of variable stars. This task has been energetically fulfilled by Prof. T. Banachiewiez, and the seventh annual volume has just appeared. The descriptive matter is given in two languages, Polish and Peano's simplified Latin. The latter is easily read by any one with an elementary knowledge of Latin or the derived languages.

There is a useful index to the ephemerides and notes on certain stars. Use is made of three different time systems ; the Greenwich civil day (U.T.), the Julian day, and the new system proposed by the author, which begins at Greenwich midnight on Jan. 0, 1801. Tables are given to reduce from any of these systems to the others. The volume contains other useful tables, of precession, obliquity of ecliptic, moon's equation, etc.

THE BRIGHTNESS OF THE NEBULÆ.—*Ast. Nach.*, 5609, contains a paper by A. Markov of Pulkovo on the brightness of the spiral nebulæ. He has used both his own observations and those of many other observers, in particular Dr. Wirtz of Strasbourg. He concludes that the brightness of the spirals is far too high to be explained by reflection from the galaxy, as was suggested by Prof. Lindemann. He finds the surface brightness of the Andromeda nebula to be abnormally high, twelve times that of the average spiral, and seventy-six times that deduced for the galaxy ; the latter, according to its surface brightness, though not according to its size, is to be ranked among the faint spirals. The star-density in the Andromeda nebula is concluded to be unusually great, and confirmation of this is drawn from the large number of novæ that have appeared in it. Its central brightness (measured from a square 1″ in the side) is given as 17 mag., falling to 21 mag. at a distance of 5′ along the minor axis. The Pulkovo results give the value + 0·68 mag. for the average colour index of the spirals.

The paper also deals with gaseous nebulæ ; the photographic brightness of some of them was found to be lower than the visual brightness. Their brightness as a whole is stated to be of the same order as that of the gas in an exhausted tube under the influence of soft cathode rays.

Research Items.

MARRIAGE IN AFRICA.—In *Man* for January, Mr. E. Torday examines critically the terms in use in relation to the consideration which passes between the contracting parties among African peoples at the time of marriage. It is now almost universally admitted that marriage does not consist of a purchase. Among the Amazulu, for example, the bride remains a member of her clan, and the contract may be sealed by a mere trifle, such as a hoe or basket of corn as well as by many head of cattle. Among the Natal Kaffirs the amount was fixed by disinterested parties. The natives themselves repudiate the idea of a sale, and on the Congo the Boloki regarded the gifts of food and sugar-cane wine as proof that the woman was not 'sold as a slave,' but 'given as a free woman.' As a matter of fact it is among those peoples where the bride-price is not given that marriage is most irrevocable. 'Bride-price' is therefore absurd, and 'dower' and 'settlement' are not more appropriate, as these terms should be reserved for customs which really belong to these classes, such as the hoes which a girl received from her father among the Chaga at circumcision and takes with her on her marriage, and the settlements of cattle made by the Bamangwato father to serve his daughter during her marriage and in case of widowhood. The use of specific native terms is to be deprecated, as notwithstanding their obvious accuracy they lead to confusion and the exact implication is not clear to the ordinary individual. The sealing of the contract is the act of paramount importance. It takes place between groups and not individuals, and each group pledges itself to see to the carrying out of the contract. Hence if the wife fail, the group supplies her place by offering a sister or other equivalent and thus recognises its obligation to continue the performance of the contract. Further, the consideration, whatever it may be, may be divided among the members of the bride's clan or group. Tentatively, 'earnest' is suggested for discussion, as implying the undertaking to ensure the due observance of the contract.

HARAPPA IN THE VEDAS.—The early culture discovered at Harappa in the Punjab and Mohenjo-Daro in the Indus Valley up to the present has been regarded as of non-Vedic type, and it has been stated that there is no indication that the builders of these cities were akin to the Rig-Vedic Aryas. Sir John Marshall thinks the most reasonable view is that they were the pre-Aryan (probably Dravidian) people known in the Vedas as the Dasyus or Asuras, whose culture was destroyed in the second or third millenium B.C. by the invading Aryans. In the *Indian Antiquary* for January, Binode Behari Ray Vedaratna puts forward a claim that these relics belong to the Aryan civilisation. In ancient times, when the Aryans inhabited the Sapta-Sindhu region and the Punjab, perhaps they erected two cities on the god-made land —the alluvial land on the bed of the Sindhu-Samudra. There was in Vedic times a city named Hariyupia, where a battle was fought between King Abhyavarti and Varashikha's sons in which, Indra fighting on the side of the former, the latter were defeated and slain. Another battle was fought between Kavi, brother of Abhyavarti and the Aryan invader Sudas in which, again through the aid of Indra, Kavi was defeated and slain. This battle was fought near the river Parushi (Râvi). If the city Hariyupia was on the bank of the river, it may be Harappa which is on the eastern side of the Râvi. Abhyavarti and Kavi appear, therefore, as kings of Harappa who fought against the invader. Sudas was contemporary with King Trasadasyu, who reigned in the fifth millenium. Abhyavarti was an emperor from whom Bharadvaja Rishi received offerings of cows and other things. It may therefore be concluded that he was an Arya of the Prithu dynasty, who lived in the fifth millenium, and that at that period Harappa was the capital of an Arya emperor and was not non-Aryan.

'FUNNEL-MOUTHED' TADPOLES.—The function of the 'funnel' mouth of certain *Megalophrys* tadpoles has been for some time a subject for investigation. Dr. Sunder Lal Hora, in his latest communication ("Further Observations on the Oral Apparatus of the Tadpoles of the genus *Megalophrys*." *Records of the Indian Museum*, vol. 30, pt. 1, 1928), describes the results of his most recent researches into the habits of these interesting larvæ. The tadpoles of *Megalophrys parva* are abundant in shallow, swiftly running streams, and are to be found in the sheltered parts of these where they have not to contend against the torrential currents which are liable to carry them away. In such situations they do not hang from the surface film and feed as they may do in quiet waters, the oral apparatus enabling them to feed at any level, even at the bottom, and the funnel when folded helping by excluding large, and probably facilitating the entry of small, particles in flowing waters. Whilst this oral apparatus helps to make the anterior end buoyant, the developing lungs distended with bubbles of air apparently act as hydrostatic organs and enable the animal to suspend itself at any particular level, making the whole body buoyant—a distinct advantage when it is carried away by a flood. Living thus in hill streams which are liable to break up into a series of pools and puddles, dry up altogether, or become rapid torrents generated by a single shower, the tadpoles, according to Dr. Hora, have adapted themselves to such variable conditions and evolved the funnel mouth and hydrostatic lungs.

SELECTIVE FACTORS IN SALMON MIGRATION.—In spite of the attention given in recent years to the influences which determine a salmon's selection of a particular river for spawning purposes, the subject is still very obscure. It is clear enough that the responses to some sort of stimulus are very specific, for not only do salmon in Great Britain often return to that very river from which they set out, but also in Canada it has been found that distinct races of salmon occur in definite tributaries in the same river system, so that even selection of tributaries must be made. Dr. R. E. Foerster's observations on the migration of sockeye salmon in the Cultus Lake area of the Fraser River bear on the relations of temperature, hydrogen ion concentration, and oxygen to the up-stream movement (*Canadian Field-Naturalist*, January 1929). He found that while one race of sockeye salmon may, at the junction of two streams, select the colder, another may prefer the warmer; and that the same race may at one point ascend the colder and at another the warmer of the alternatives. Temperature, therefore, cannot be a prominent directing influence. As a rule the migrating salmon preferred a water with somewhat lower hydrogen ion concentration, and yet they avoided the waters of Sumas Creek, always lower in this factor than Sumas River. Indeed, the conclusion seems to be that neither temperature, hydrogen ion concentration, nor oxygen content can be regarded as simple factors by which selection is determined, although it is reasonable to suppose that some physico-chemical attribute or attributes of the waters traversed, either singly or in association, direct the route of migration.

INDIAN DEEP-SEA SPONGES.—In his "Report on Some Deep-Sea Sponges from the Indian Museum collected by the R.I.M.S. *Investigator*, Part 2, Tetraxonida (concluded) and Euceratosa" (*Records of the Indian Museum*, vol. 30, pt. 1, 1928), Mr. Burton continues his study of deep-sea sponges. These are of great interest. Two specimens of *Biemna annexa* (Schmidt) were found, hitherto only recorded from the North Atlantic. The diagnosis of *Sceptrospongia coronata* is based on a partial description by Dendy given in relation to his study of the origin and growth of sponge spicules. These spicules are highly elaborate, as was shown by Dendy, who directed attention to their variable character, and the figures given in the present paper show the many different forms present in the one sponge. The genus *Bubaris* is revised, the author removing five species to other genera and retaining thirteen, including three new species. These deep-sea sponges form a remarkable and valuable collection. The paper is well illustrated by text figures and two photographic plates.

AUSTRALASIAN MOLE-CRICKETS.—In the *Records of the South Australian Museum*, vol. 4, No. 1 (1928), Mr. Norman B. Tindall reviews the Australasian species of Gryllotalpidæ, which have been much neglected by recent workers. He defines these insects as crickets of subterranean and aquatic habits, with the anterior legs adapted for burrowing and the ovipositor obsolete in the females. All the members are water-loving, frequenting light soils and sandy ground where there is ready access to moisture, but it would seem that the term aquatic is not strictly applicable. It is generally assumed that only male mole-crickets are capable of sound-production, but an examination of any of the females of the Australian species of *Gryllotalpa* will show an apparatus on the under side of the elytra, with which individuals are capable of making themselves heard. Several species are of economic importance on account of their underground burrowings, which injure certain root crops, besides helping to crumble the banks of water channels and dykes. A matter of considerable interest is the recent importation of the Surinam toad (*Bufo agua*) from Porto Rico into Barbados for the purpose of destroying the mole-cricket *Scapteriscus vicinus*. Mr. Tindall's paper is admirably illustrated and forms a useful contribution to Australian entomology.

SIBERIAN METEOROLOGY.—The Vladivostok Observatory, now designated the Geophysical Observatory of the Far East, has resumed publication of the meteorological observations from eastern Siberia. Two parts of the *Annales de l'Observatoire central* give respectively the figures for 1916 and 1917, thus continuing the series that have already appeared. The Director announces that it is hoped to publish succeeding years' work shortly and then to resume annual publication. The records come from about a hundred stations in the Amur and coast regions, Kamchatka, Sakhalin, and so far north as Anadir. Monthly means are given for temperature, vapour tension, humidity, cloud and wind for the seventh, thirteenth, and twenty-first of the months. Pressure, maximum and minimum temperatures, precipitation, and other data are also given. Although there are gaps in some of the stations records, the observations are remarkably full and detailed. The text is in Russian but headings are given also in French.

ENVIRONMENTAL FACTORS OF PHILIPPINE BEACHES.—Mr. Raymond Kienholz, in his paper "Environmental Factors of Philippine Beaches, with Particular Reference to the Beach at Puerto Galera, Mindoro" (*Philippine Journal of Science*, June 1928), records various climatic observations with regard to temperature and rainfall; and relative humidity, evaporation, wind, sunshine, and soil on a sandy beach, rocky headland, and mangrove swamp. The author in a former communication (*Proc. Am. Phil. Soc.*, **65**, No. 5 Supplement; 1926) has discussed the effect of these factors upon the vegetation, especially with regard to the leaf. The climate of the Philippines is essentially tropical. The temperature is very uniform, with only slight seasonal and daily fluctuations, and the rainfall is extremely variable, but there being no dry season at Puerto Galera enables many plants to grow on the beaches all the year round, which are limited to the wetter months in other parts of the islands. The relative humidity is usually high. The amount of evaporation measured by means of standardised Livingston atmometers is highest at the rocky headland, lowest underneath the mangroves. The rate of evaporation is closely correlated with the amount of wind, and the high evaporation rate in spite of the fairly high humidity is probably the reason for certain structural adaptations of the leaf for conserving its water supply.

GEOLOGY OF BRITISH HONDURAS.—Between 1921 and 1926, Mr. Leslie H. Ower was actively engaged in a geological investigation of the only British possession on the mainland of Central America. As the territory has hitherto been very little known, a sketch of the geology from Mr. Ower in the *Jour. Geol.*, pp. 494-509; 1928, is particularly welcome. British Honduras consists of a central peneplain of folded Upper Carboniferous marine beds, with granite intrusions, surrounded by unfolded limestone of about Oligocene age. Deposits of ages between these two periods are unfortunately unknown. The main movements can be referred to Permo-carboniferous and Miocene diastrophism. The trends of the Palæozoic rocks conform to those of Honduras and Guatemala, all following a series of generally east-west folds that arose out of the Honduranian geosyncline. Granite intrusions follow the crests of the folds. Much more youthful north-east to south-west features are common, these being parallel to the trends of western Cuba. The east coast is determined by large faults which descend rapidly into 2000-fathom water. It is noteworthy that British Honduras suffered no folding during the building of the Central American mountain system. This began in the Miocene, and is apparently still active. British Honduras, however, is outside the severe earthquake zone of the present day.

MINE VENTILATION.—The Engineering Experiment Station of the University of Illinois is continuing its experiments upon mine ventilation, and has just issued in *Bulletin* 184 the third part of a paper upon the measurement of air quantities and energy losses in mine entries, by Messrs. A. C. Callen and C. M. Smith. This *Bulletin* refers wholly to measurements of air (and the calculations based thereupon) carried out at one of the mines of the Peabody Coal Company. The investigation has been done with great care, and a number of interesting results have been obtained and recorded, but it is very doubtful whether these can be of any general application, seeing that they depend entirely upon the special conditions obtaining at this particular mine and do not allow of any general deductions from them.

THE ISOTOPES OF NEON.—In a paper which appeared in the *Philosophical Magazine* in 1920, Dr. F. W. Aston mentioned that neon appeared to possess a third isotope, of atomic mass 21, in addition to its two well-established components of masses 20 and

22, but he made no reference to this in his Bakerian lecture in 1927. T. R. Hogness and H. W. Kvalnes, who have been using the same gas to calibrate another form of mass-spectrograph, now report that a peak corresponding to a singly charged ion of mass 21 invariably appears on their curves, and since they find no trace of a peak for an ion of mass 23 which could be attributed to a hydride of Ne^{22}, this cannot be due to a hydride of Ne^{20}, and is therefore ascribed by them to the third isotope of neon. Their measurements, which have been published in the December number of the *Physical Review*, show that Ne^{21} atoms are rare, constituting only about the fiftieth part of ordinary neon, and they suggest that Dr. Aston did not detect them in his later work because the high resolution of his apparatus had been partly attained at the expense of its sensitivity.

THE DIFFRACTION OF ELECTRONS BY MICA.—A number of cathode ray diffraction photographs are published by S. Kikuchi in the June issue of the *Proceedings of the Imperial Academy of Japan*. They were obtained with mica in an apparatus similar to that used by Prof. G. P. Thomson, and were primarily designed to show the electron analogue of the Laue phenomena for a crystalline plate, but actually proved to be more complicated. Very thin sheets of mica were found to produce an equilateral pattern built up of lines intersecting at sixty degrees, with enhanced spots at the angular points, whilst thicker sheets gave both Laue spots, diffraction circles, and sets of bright and dark lines with a unit angular spacing of thirty degrees. The author has not attempted to account for all these effects in detail, although they are evidently in general agreement with the requirements of the wave mechanics, but he points out that the circles are apparently formed as the result of diffraction of the electron waves by a linear array of atoms, and that absence of this type of interaction in the case of X-rays may indicate the existence of a fundamental difference between light waves and material waves.

CUTTING OILS.—In a lecture on cutting and quenching oils delivered by Mr. C. H. Hudson to the Junior Institution of Engineers on Dec. 21, the functions of a cutting oil were defined as: (1) to lubricate the chip over and along the lip of the cutting tool and so lengthen the latter's life; (2) to disperse as rapidly as possible the heat generated by cutting; and (3) to wash away the chips, keep the work clean and prevent clogging of the machine by the accumulation of swarf. In the case of soluble oils, it is essential that there should be no free acids which, if present, would cause corrosion, nor are oils made from a rosin base desirable as they tend to cause gumming of the moving parts of the machine tools on which they are used. The use of a lard or lard substitute cutting oil was advocated on automatic lathes and other machine tools where long tool life and working to very close limits is essential. It was emphasised that the lowest priced soluble oil is not always the most economical, as the cheaper grades will not bear the same dilution and give as good results as a higher grade oil; the latter can be diluted in the proportion of 30 to 1 and the former 20 to 1, which shews a saving of one farthing per gallon in favour of the more expensive solution. For operations on some special metals and other substances special lubricants and cooling agents are used, such as paraffin for soft aluminium alloys, or turpentine, in glass boring and shaping. In some works lard oil and white lead mixed to a gummy consistency is used when reaming and tapping high carbon and alloy steels. In the United States compressed air is used as a cooling fluid in some operations with notable success, for example, in the milling and drilling (usually done dry) of cast iron. The air absorbs the heat generated without producing the glazing effect which takes place if an oil is used. In connexion with methods of distributing oils to the cutting tools, a large flow of oil at comparatively low pressure is far better than a small flow at high pressure.

COOLING LARGE TRANSFORMERS.—During the last few years, the size of the transformers used for converting high-pressure alternating current into low-pressure alternating current has been continually increasing. According to *A. E. G. Progress* for November, several units having an individual output of 60,000 kilovolt amperes (kva.) at 220,000 volts are now in course of construction. In the A.E.G. (Allgemeine Elektricitäts Gesellschaft) works, a transformer with an output of 100,000 kilowatts is used for testing purposes. If we assume that the power lost at full load is only one per cent, the heat generated in the transformer itself would be equal to that developed by 500 electric fires all on at once. It will be seen, therefore, that very special methods have to be adopted for cooling it. Since the heat losses in a transformer increase very approximately as the cube of the linear dimensions, and the cooling surface increases only as the square of the linear dimensions, the difficulty of the cooling problem increases rapidly with the size of the transformer, provided that the cost is to remain proportional to the output. For transformers immersed in oil contained in a corrugated iron tank, self-cooling can be used up to outputs of about 5000 kva. The cooling is sometimes accelerated by forcing draughts of air along the sides of the tank. Another system frequently used is to have pipes through which water is kept circulating immersed in the upper portion of the oil. The quantity of water required per hour for a 10,000 kva. transformer having an efficiency of 99 per cent is nearly 2000 gallons, the temperature of the oil being maintained at about 100° F. The A.E.G., instead of forcing the water through the pipes, now draws it through by a suction process. In this case if the pipe springs a leak the only thing that happens is that the oil enters the water and not vice versa, which would ruin the insulating power and the electric strength of the oil. Details of many other interesting methods are given.

STRUCTURE OF ETHYLENE.—The November issue of the *Indian Journal of Physics*, which is largely devoted to measurements of the physical constants of organic substances, contains a paper by V. I. Vaidyanathan on the magnetic properties of ethylene. In spite of the simplicity and importance of this compound, no determination of its susceptibility appears to have been made since Quincke reported it to be feebly paramagnetic. From its constitution it should be diamagnetic, which has now been shown to be the case, the value of the molecular susceptibility ($1{\cdot}5 \times 10^{-5}$) being close to that calculated from Pascal's additive law ($1{\cdot}8 \times 10^{-5}$). It is also at least a remarkable coincidence that the molecular susceptibility of ethylene is almost identical with the atomic susceptibility of sulphur. The two substances have sixteen electrons to the molecule and atom respectively, and this result might be regarded as confirming the view, which is now fundamental in the quantum theory of molecules, that the properties of a molecule are intimately connected with those of an atom with the same number of electrons. The author has not been able to come to any definite conclusion as to the structure of ethylene, but he has pointed out that it probably contains only four electrons which are moving in large orbits, and that on this assumption the value of the effective molecular radius deduced from the susceptibility (1 A.) is in reasonable accord with that obtained from the viscosity of the gas.

The Grid Transmission Scheme in Great Britain.

THE Electricity Act of 1926 authorised the creation of the Central Electricity Board. To this Board was entrusted the work of constructing all the transmission lines required for interconnecting the power stations selected for supplying the national requirements for electrical energy. It had also to supply energy to undertakings which had no power stations. In a paper which was read before the Institution of Electrical Engineers on Jan. 24, Messrs. Johnstone Wright and C. W. Marshall described what has already been done and gave an outline of the projected scheme.

It has to be remembered that although British engineers knew how similar schemes had worked on the Continent and in America, yet they have developed on somewhat different lines in these countries, and it is no easy matter to say which is the best. In Great Britain the sources of energy are not only comparatively close together but they are also close to their consumers. In this case the main function of the transmission line is to allow the generating plant only to operate at its most efficient load, and at the same time to reduce to a minimum the requisite stand-by plant. This has been done to a limited extent by existing power stations. The novelty of the grid scheme lies in the high voltage employed for this purpose and the magnitude of its operations.

The system of supply adopted is three phase, and the pressure of supply between any pair of wires is 132,000 volts. The standard frequency of 50 is adopted. To illustrate the comparative smallness of the British system, a map of the British Isles is shown superimposed on the area of a single large interconnected system in the United States and is nearly covered by it. With the exception of Italy, the systems of supply adopted in Europe are very similar. The pressures in France vary between 110 and 150 kilovolts. The majority of German lines work at 110 kv., but there are lines in course of construction which will work either at 220 kv. or 380 kv. The Spanish scheme is an interesting one, as it provides for a 220 kv. ring main with feeders and distributors at 110 kv. High tension lines already stretch along the north of Spain from Barcelona to the north of Portugal. Lines operating at 132 kv. are very extensively used in America and these systems are continually being extended. The length of the lines operated at this voltage in America is 3824 miles. The complete British system will comprise 2600 miles of circuit, the wires being suspended overhead.

The wires are designed so that whatever the load the variation from the normal voltage will not exceed ± 5 per cent. The choice of the metal to be used for the conductors was determined largely by its mechanical properties. The difficulties in getting way-leaves and tower sites made it essential to use spans of the maximum permissible length. The selection of steel-cored aluminium conductors gives general satisfaction. In the case of a flash-over the steel core prevents the conductor from being burned out. So long as the aluminium remains sound, the steel core is protected from the atmosphere. The life of the aluminium therefore determines the life of the cable. Tests show that this life is at least twenty-five years. The standard conductor consists of a central core of 7 strands of galvanised steel wire surrounded by two layers containing 12 and 18 strands respectively of aluminium wires. Every strand is 0·11 inch in diameter, and the conductivity of the conductor is equivalent to that of a copper conductor 0·175 square inch in sectional area, and its normal current carrying capacity is 219 amperes. The size of the conductor being much greater than if it were of copper, brush discharges do not ensue until under normal atmospheric conditions the voltage attains 184 kv. At less voltages the loss due to brush discharges is negligibly small.

The towers used in various countries to support the wires are of very different designs. Steel, reinforced concrete, and even wood have been used in their construction. In the choice of broad-base towers made of steel for the grid, æsthetic considerations played a considerable part. The choice of broad-base or narrow-base towers was generally determined by way-leave considerations. The double-circuit towers are 18 ft. 6 in. at the base and 78 ft. high.

The conductors are supported by strings of insulators, generally nine in number, the working load on which is 4000 lb. These chains are subjected to very rigorous, mechanical, electrical, porosity, and thermal tests. A temperature-cycle test is made on each unit by immersing it in water at 93° C. for an hour, and then immediately plunging it into a mixture of ice and water. The voltage distribution test consists in determining the fraction of the total voltage that is borne by each individual unit of the chain.

The most difficult problem the engineers had to solve was to devise an efficient protective system for the grid, and for solving this not much help could be obtained either from American or Continental practice. Owing to the high voltage and the consequent wide space between neighbouring lines, there is not much risk of trouble from birds and branches of trees. Possibly also the wide spacing diminishes the risk of trouble from atmospheric discharges. The solution adopted is to depend on earthing the system by means of a high-conductivity earth wire and to use 'arcing' rings for the insulators. The authors state that 'the earth wire serves the double purpose of acting as a definite return for fault currents, and as an electrostatic screen to reduce voltages induced by lightning.' They are going to use no 'lightning arrestors,' at least in the first instance. In their opinion the comparatively few thunderstorms which occur in Great Britain do not justify the use of these protective devices.

It appears that in the grid the neutral points of the transformers, etc., will be directly connected with the earth. It is anticipated that the excess current relay will trip the line when an atmospheric discharge takes place, and so the arc will be suppressed and no serious interference with the supply will ensue. According, however, to *A.E.G. Progress* for December 1928, practical experience does not bear out this anticipation. It is known that momentary shocks are sufficient to throw extensive networks out of step, especially when working near their critical load. The German engineers operate with insulated neutral and use the system of coils invented by Prof. Petersen to suppress the arc. This system has been in operation for ten years, and on the Continent the number of networks adopting it is continually increasing. The 100 kv. network supplying South Germany, and owned by the Rhine Westphalian Electricity Company, is now adopting this system exclusively. The entire new 220 kv. system of this Company will be equipped with Petersen coils. In our opinion the reasons advanced in favour of the Petersen coils by the engineers of the Allgemeine - Elektricitäts - Gesellschaft should be seriously considered.

The question of inductive interference between power lines and communication lines has been discussed by the International Consultative Committee, and a résumé of its results is given in the paper.

We are glad that the danger from electrostatic induction is recognised. Danger exists from electrostatic induction for a distance of about 400 yards on each side of the 132 kv. lines. The maximum allowable pressure induced in a communication line has been fixed by the I. C. C. as 300 volts. Formulæ are given by the I. C. C. to enable the induced electromotive force to be computed. They are given in terms of Bessel's functions, but as these functions are written in the form $J(x, y)$ and are apparently functions of two variables, we fail to understand what they mean. It is stated with great emphasis that it has been definitely decided that, from the point of view of interference with communication circuits, the earthed neutral system is better than the insulated neutral system. There is nothing new in the statement that the resistivity of the matter forming the earth's surface is a predominant feature in determining the induced voltage. This was known many years ago. As a matter of fact the electrical resistivity of the surface ground varies from day to day.

The problems that will arise in connexion with this huge network of overhead wires have hitherto received little consideration. Its capacity to earth cannot be neglected, as it is very large. If it were insulated at every point, then if it sparked to earth the high pressure behind the spark would maintain a continuous arc the current in which might easily be hundreds of amperes. In the Bayernwerk network in south Germany (1250 miles of overhead wires) the capacity current in the arc has been computed to be between 500 and 600 amperes. It is stated, however, in *A. E. G. Progress* that the Petersen coils suppress the arcing flame at the faulty point almost instantaneously.

Standard substations of six types have been adopted. The minimum spacing between conductors of different phases is nine feet. All the transformers are designed for outdoor working. If their capacity exceeds 30,000 kva., then owing to the difficulties of transport they are made up of three single-phase units star connected. They are all provided with voltage-regulating equipment. Transport considerations made it necessary to use extremely strong tanks, as each transformer has to be capable of being transported completely immersed in oil by rail, road, and sea.

In the Scottish system the River Forth is crossed near Kincardine by a span 3050 feet in length. The suspension towers are each 338 feet high and the high-water clearance is 158 feet. The span is anchored at each end on 60-foot towers. Double chains of suspension insulator units are used. Each chain consists of 11 insulators. The total working stress is 20,000 lb.

An excellent map is given of the projected scheme of high-tension transmission lines for Great Britain. The Scotch scheme, which is nearest completion, shows that Carlisle, Edinburgh, and Glasgow will all be connected by a ring main. There are four large hydroelectric stations between Dundee and Inverness. The concentration of large stations on the Clyde is noticeable. Between Liverpool, Manchester, Leeds, and Sheffield there are many large power stations, and similarly round Birmingham and in London. Cambridge will be in direct connexion with Lincoln and London. Along the south coast of England the transmission lines will extend from Plymouth to Folkestone through Southampton. From Southampton they will extend to Bristol, Worcester, Cardiff, and South Wales. In North Wales there are several large hydroelectric generating stations, but these are not in connexion with the grid.

A few tables of the constructional costs for Scotland are given. For normal lines the costs of the lattice towers account for nearly half the total costs. The costs of the conductors are 30 per cent, and of the insulators 11 per cent of the total. The costs of the large high-tension transformers used average about 14 shillings per kilovolt ampere at 10,000 kva. size to about 5 shillings per kva. at 60,000 kva. size. The price of a small substation equipment averaged about £20,000. For larger substations the cost was about twice as much.

Structure of the Stars.

ON Friday, Feb. 1, Prof. A. S. Eddington delivered the fifteenth Thomas Hawksley lecture before the Institution of Mechanical Engineers, on "Engineering Principles in the Machinery of the Stars." In introducing a general account of his well-known theory of the internal constitution of the stars, Prof. Eddington remarked that although modern physics is tending to show that engineering principles are not fundamental in the constitution of the universe, yet Nature does contrive to produce engineering work on the grand scale, much of which is exemplified in the structure of the stars. He then proceeded to amplify this statement by regarding a star as a power station, and considering the questions of its equipment and fuel supply.

The latter question is still in a very unsettled state, and although there are strong grounds for accepting provisionally the hypothesis that a star's heat is provided by the destruction of matter inside it, there are some observational results which are hard to reconcile with this. The lecture was framed in characteristic language, embodying Prof. Eddington's customary charm of expression. A typical example is the following statement of the somewhat recondite 'exclusion principle' of modern atomic physics:

"In general terms it means that every electron insists on being in some way a little bit different from its neighbours. So when pressure tries to insist on electron A packing a little closer to electron B, A replies 'No. We are already so nearly in the same position that people can only just manage to tell us apart.' But it is open to persuasion by an offer of some other distinction as a substitute for difference of position. If A differs sufficiently from B in energy or in momentum, that will do just as well. So at high temperatures when there is plenty of energy to go round, the electrons can distinguish themselves by seizing different quantities of it, and then they will not mind losing their distinction by position. Poor things! they are all turned out exactly to pattern by Nature's lathe, so they treasure these ways of insisting on their individuality—not to be just like one's neighbour. And so it comes about that at low temperatures the exclusion principle devotes its efforts to separating the electric charges in position and gives a large effective volume to the atom, whereas at stellar temperatures it is more concerned with distinguishing their momenta and energies, and is lax about keeping them apart in position."

Prof. Eddington referred to the possibility that a star might be regarded as being in "a rather remarkable state, namely, a crystalline gas." He does not think the gas inside a star is crystalline, but that it is not so far removed from that condition that we can leave the possibility out of all consideration. In any volume inside a star there are a few big positive charges (atomic nuclei) and a relatively much larger number of small negative charges (electrons). The former tend to take up a configuration of minimum energy, which is that of a crystal lattice, while the

latter spread fairly uniformly over the volume. The energy of agitation tends to stir the material and 'melt' the crystal, but the crystalline state is a fair approximation to the actual condition. The gaseous character of the material would be manifested chiefly in its mechanical properties of expansion and compressibility, while the crystalline structure would appear chiefly in the optical properties.

A discussion of Cepheid variables regarded as pulsating stars occupied a considerable portion of the lecture. Although the difficulties of the conception have not been completely overcome, Prof. Eddington regards them as by no means serious. The problems set by such stars have led him to the view that the influence of temperature and density on the rate of liberation of sub-atomic energy must be an indirect one. "The energy is released from certain active substances formed inside the star; the rate of formation of these substances increases with temperature and density, but they break up and liberate the energy at a rate unaffected by temperature and density."

Museums and Education.

SIR HENRY A. MIERS accomplished a great work for the museums of Great Britain when he wrote his report for the Carnegie Trustees, but that report was designed more particularly for museum committees and museum curators, and its appeal was for the specialist rather than the public. Now Sir Henry adds a second to his former accomplishment, for he has gone out into the wilderness to preach the gospel of museums to the people. This is as it should be, for it is to the apathy of the public and the dislike of intellectual effort, observable even where first-rate museums offer no excuse for it, that much of the inefficiency of museums can be traced.

On Jan. 23, Sir Henry Miers delivered an address on "Museums and Education" to the Royal Society of Arts, when the Right Hon. The Earl of Crawford and Balcarres, himself known for his wide interests in museums, was in the chair. Readers familiar with the strictures of the report will be prepared to learn that his address was not a gospel out and out, but underlying the very just criticisms which he made of certain types of museums, of curators, and of the public, lay a deep current of optimism in the educational possibilities of museums, and in a rejuvenated future in which they would take their due place in the development of the nation's outlook and thought. His address fell into two broad sections: in the first, he displayed the weaknesses and inefficiencies of many museums as they now exist, and showed how these had a direct and unfavourable repercussion upon the people's museum outlook. In the second, he pointed the way in which steady improvement might be made, by a reorganisation of museums towards special ends.

Sir Henry Miers' general criticisms of local museums as they are are familiar to readers of NATURE. He summed them up in the course of his lecture: "There are many signs of improvement in the general situation, but, when all is said, it must be confessed that the large majority suffer from over-exhibition, lack of policy, and the fatal habit of accepting miscellaneous gifts, so that of the service which they might render throughout the country a very small part is actually fulfilled by them."

Perhaps it is more profitable to dwell on Sir Henry's constructive suggestions. He founded his proposals on the proper assumption that museums are designed for the use of four distinct categories of visitors: the ordinary, more or less casual, visitor; the local student, whether he be of ripe years or an elementary scholar; the definite and purposeful collector and inquirer; and the scientific research worker. Not every museum can cater for each of these groups, but the principle of appeal for any group ought to be similar wherever it has a place. Thus it is most fitting that for the ordinary visitor the nature and resources of the town or district should be displayed, the labelling should be thorough yet simple in word, and easy transitions should lead from one collection to another of different kind.

For school children and older scholars, summary collections or introductory series are desirable, and Sir Henry said a true word when he stated that the writing of lucid, accurate, and short labels is a very difficult task, requiring much care and thought, and, we would add, experience. For the collector, the introductory series must be supplemented by systematic collections, and for the research worker, to these must be added great stores of classified and authenticated material.

A strong appeal was made for the strengthening of the Museums Association, as a correlating body, for the extension of interaction and inter-lending between the national and local museums, and for the creation of a type of museum new to Great Britain, the 'folk museum,' which would depict in complete units the life of English (why not British ?) people through the ages.

Culture Sequence in the Swiss Lake Dwellings.

OWING to lack of supervision and organisation in the earlier explorations of the Swiss lake dwellings, chronological data relating to the finds are scant. As, however, investigations were for the most part of a superficial character, many sites were left undisturbed except for the topmost layer. Some of these have now been explored by M. Vouga under the auspices of the Neuchâtel Committee for Archæological Research. A summary of the results is given in *Antiquity* for December.

The civilisation of the Swiss lake dwellings up to and including the Copper Age is represented by two phases. The older appears in a single stratum, while the second consists of two or three superimposed. These are distinguished as lower, middle, and upper Neolithic and Eneolithic ages. They are separated each from each by a barren layer of a certain thickness. It is to be noted that in the deposit of the first occupation, which always rests on the lacustrine bed, the objects found are for the most part of a much more advanced technique than those found in the upper layers. This is particularly true of the pottery, which reaches a high grade of excellence. Here, too, the flint is dark brown, semi-transparent at the edges, and not the opaque white, dusky, or black local product. The spindle-whorl seems unknown.

The middle Neolithic has been called the *bel âge de la pierre*, but that appellation must now be abandoned in view of the finds in the hitherto neglected lower Neolithic. It is, however, still the most important settlement, its deposit sometimes being a metre thick. The remains of the habitations have generally been destroyed by fire. Its flint work is richer and more varied than in the early stratum, the 'type-fossil' being the arrow-head. The pottery has degenerated, and gives the impression of an art in its infancy.

The upper Neolithic is a normal evolution of the middle, of which it represents merely an advanced

phase, though separated from it by a barren deposit. As a rule it forms the base of the archæological deposit of the Copper Age, which is found inland, proving that the waters stood at a higher level in the late Neolithic period.

The Eneolithic age evolves normally from the preceding Neolithic. The fact that the upper strata of this period were disturbed at a very early date points to the cultivation of the ground by the succeeding people of the Bronze Age. The occurrence of the Bronze Age dwellings at a greater distance than the Neolithic from the present shore points to a period of drought rather than to greater technical skill.

University and Educational Intelligence.

BIRMINGHAM.—The report of the Vice-Chancellor to the Council for the year 1927–28, which will be presented to the Court of Governors at the annual meeting on Feb. 21, has been issued. The number of students for the session showed an increase on that for the preceding year, and a further increase appears in the present session. Pleas are advanced for the extension of the residential accommodation for women students, for an increase in expenditure on the library, and for more scholarships with which maintenance grants must be associated. The appointment of some senior members of the non-professorial staff to Grade I. is urged on the ground that, if retirement at the age of sixty is compulsory, those who have not held for some ten years a post with a salary of not less than £600 are entitled only to a pension which is quite inadequate to services rendered. The Vice-Chancellor reports that the voluntary medical examination of women students on entering the University, which was instituted two years ago, has met with complete success, and it is hoped that similar facilities may be offered to men students. The report of the Joint Standing Committee for Research records a substantial output of research during the session.

CAMBRIDGE.—A syndicate consisting of the Vice-Chancellor; Sir J. J. Thomson, Master of Trinity; Prof. Seward, Master of Downing College; Dr. Willis, Dr. A. W. Hill, Dr. H. Hamshaw Thomas, Prof. A. G. Tansley, Sherardian professor of botany in the University of Oxford; A. Amos, R. A. Hayes, and F. L. Engledow has been appointed to consider the organisation and finance of the Botanic Garden and the relations between the Garden and the Department of Botany and other scientific departments, and to report to the University by the end of the ensuing term.

EDINBURGH.—At a meeting of the University Court on Jan. 28, Principal Sir J. Alfred Ewing intimated his intention to retire from the principalship of the University on Sept. 30 next.

ST. ANDREWS.—The Prime Minister, the Right Honourable Stanley Baldwin, has been elected Chancellor of the University and has written to Principal Sir James Irvine accepting the appointment.

RECENTLY Mr. Paul F. Williams, a well-known engineer and business executive of Chicago, Illinois, established the Paul F. Williams Research Foundation Fund for the promotion of scientific research at Purdue University, West Lafayette, Indiana. This fund provides for several one thousand dollar annual research fellowships. At least two of these will be available for physical research in the Graduate School of the School of Science. This is but one of the many evidences of the business man's interest in the building of a research centre at Purdue University, where knowledge may be created through fundamental research and applied through industrial research.

Calendar of Patent Records.

February 9, 1832.—During the steam-carriage boom that started about 1821 and lasted some years, several companies were formed and projected to run lines of coaches. The London and Birmingham Steam Carriage Company built in 1833 a coach of the type invented by Dr. William Church of Birmingham, and patented by him on Feb. 9, 1832. The coach had a single front wheel and was carried on air springs; its driving wheels were 8 ft. 6 in. in diameter, and had elastic rims and spokes; they were mounted on separate axles and geared by chains to the engine shaft. The carriage did not prove very successful and was not used after a few short trials.

February 10, 1801.—Green-houses for vines and other plants came into general use during the eighteenth century. The first patent for a hothouse was granted on Feb. 10, 1801, to James Anderson, the editor of the rare periodical *The Bee; or Literary Weekly Intelligencer*, 1791–94, and the author of several agricultural works.

On the same day, Feb. 10, 1801, the first patent for a fire-resisting safe was granted to Richard Scott, a colonel in the employ of the East India Company. The safe consisted of an outer casing with double walls of metal and a filling of charred wood soaked in an alkaline solution, and an inner metal box supported on all sides by pins.

February 10, 1825.—A great improvement was made in the candle by the invention of the plaited wick, which became untwisted and consumed as the candle burnt. The invention was patented in France by Cambacérès on Feb. 10, 1825, but it does not appear to have reached England until some years later.

February 12, 1849.—During the first half of last century, especially after the invention of photography, the forgery of Bank of England notes was very common, and many inventors applied themselves to the problem of devising means to circumvent the forgers and safeguard the public. The new issue of notes which was made from the Bank in 1855 was printed on paper manufactured according to a process patented by William Brewer and John Smith on Feb. 12, 1849, in which the design for the watermark is engraved on steel dies and transferred by stamping to brass plates fitted within the paper-making moulds.

February 14, 1780.—The well-known letter-copying press was patented by James Watt on Feb. 14, 1780. The patent specification describes, in addition to the usual screw-press, a rolling-press, which is the form that Watt himself preferred to use.

February 14, 1876.—Several claimants, notably Reis in Germany and the Italians Manzetti and Meucci, dispute with Alexander Graham Bell the right to be called the inventor of the telephone, but it was undoubtedly on Bell's experimental work and his United States patent of 1876 that the commercial development of the telephone is based, and from which its use as a practical instrument dates. Bell's application for his original patent and a *caveat* from Elisha Gray for a similar invention at which he had arrived independently were filed in the U.S. Patent Office on the same day, Feb. 14, 1876, within an hour or two of each other, but the actual times of filing were sufficiently well authenticated to enable the Patent Office authorities to pronounce definitely in favour of the priority of Bell, and his patent was duly sealed. Applications from Gray, Edison, Dolbear, Berliner, and others, followed in quick succession, and heavy litigation was only settled by the Bell Company buying up the whole series of inventions.

Societies and Academies.

LONDON.

Royal Society, Jan. 31.—S. Chapman: On the theory of the solar diurnal variation of the earth's magnetism. A 'drift-current' theory is proposed, which may account for the major part of the solar diurnal magnetic variation, but at present a decision cannot be made between this and the 'dynamo' theory; both theories require that the diurnal convective motion in the conducting layer differs largely in phase from that observed in the lower atmosphere.—G. M. B. Dobson, D. N. Harrison, and J. Lawrence: Measurements of the amount of ozone in the earth's atmosphere and its relation to other geophysical conditions. Daily observations of ozone in the upper atmosphere show that there is a well-marked area, with much ozone, immediately to the west of cyclones, while ozone is generally small in anti-cyclones. Polar air currents in upper atmosphere are generally associated with much ozone and equatorial currents with little. There is large annual variation in amount of ozone in high latitudes, but very little in low. In autumn the amount of ozone is nearly uniform over the hemisphere.—S. Chapman and J. M. Stagg: On the variability of the quiet-day diurnal magnetic variation at Eskdalemuir and Greenwich. Corresponding daily values of percentage departure of actual from the 'normal' range of diurnal solar magnetic variation (ΔR) for the same element at the observatories are closely correlated, whereas there is much less correlation between corresponding values of ΔR for different elements at the same observatory. Actual range (R) or ΔR sufficiently characterises daily variation at any season, because variation is the same, except in scale, on days of large as on days of small range.—L. H. Gray: The absorption of penetrating radiation. Adopting the hypothesis that penetrating radiation is a type of γ-radiation, its absorption in the atmosphere is investigated from the theoretical point of view.—R. d'E. Atkinson: The probability of excitation by electron impact. Starting from the quantum theory point of view, a method is developed of analysing the results obtained by the Townsend type of experiment, in which currents of the form $i=i_0e^{ax}$ are found on varying the distance x between two parallel plates in a gas at comparatively high pressures.—N. W. McLachlan: Pressure distribution in a fluid due to the axial vibration of a rigid disc. Pressure distribution throughout the hemisphere on each side of a rigid disc, vibrating in a circular aperture in a plane wall of infinite extent, is considered. When wave-length is large compared with diameter of disc, pressure distribution is uniform over any hemispherical surface distant several diameters from disc. When wave-length is comparable with diameter, pressure decreases with increase in angular distance from axis. In general, the central zone is the only one of importance.—J. D. Cockcroft: Skin effect in rectangular conductors at high frequencies. At high frequencies the surface of the conductor becomes a stream-line in the magnetic field, and the problem of distribution of current becomes analogous to an electrostatic problem, surface current density corresponding to electrostatic surface density, whilst depth of penetration is the same as for infinite strips.—L. Rosenhead: Systems of line vortices in a channel of finite breadth. The investigations deal with a Kármán street of vortices, or unsymmetrical double row, in a channel of finite breadth. A discussion on the symmetrical double row has also been incorporated.—T. P. Hilditch and N. L. Vidyarthi: (1) The products of partial hydrogenation of some higher monoethylenic esters. A method has been worked out of determining the constitution of the isomeric acids produced in hydrogenation of derivatives of the oleic series. Methyl esters of oleic, palmitoleic and erucic acids each yield a mixture of three position-isomerides, namely, the original acid, and the two acids in which an ethylenic linkage is in either of the positions adjacent to that originally occupied. The bearing of this upon the general theory of contact action at solid surfaces is considered; the opposite geometrical isomeride of original ethenoid acid, and also formation of position isomers, seem to be due to dehydrogenation of freshly formed saturated ester prior to desorption from catalyst.—(2) The products of partial hydrogenation of some higher polyethylenic esters. The various ethenoid bonds are not usually hydrogenated at same rate, and the isomerisation phenomena discussed above are encountered. These complications are not sufficient seriously to interfere with the utility of the method as a means of determining constitution of polyethylenic derivatives.—P. K. Kichlu and D. P. Acharya: Infra-red radiations of active nitrogen. Photographic investigation of the spectrum from λ7500 to λ8900 shows that it is an extension of the first positive group of nitrogen in the green, yellow, and red regions. The most important group of lines of atomic nitrogen at about λ8200 is absent.—T. H. Havelock: The vertical force on a cylinder in a uniform stream. The method of successive images, taking images alternately in surface of cylinder and in free surface of stream, is used. The method can be applied to any submerged body for which image systems are known.—R. C. J. Howland: Stress systems in an infinite strip.—A. H. Wilson: Perturbation theory in quantum mechanics. The convergence of the series of perturbations is discussed. Though the series is not in general convergent, yet it usually possesses an asymptotic character, and its use is therefore justified.—O. W. Richardson and K. Das: The spectrum of H_2: the bands analogous to the orthohelium line spectrum.—O. W. Richardson and P. M. Davidson: The singlet bands of the hydrogen molecule (1). The strongest two band systems in the spectrum of H_2 belong to 3 to 2 electron transitions analogous to those of the parhelium line spectrum. The properties of the final state are given with great accuracy.

Linnean Society, Jan. 3.—C. E. Moss: A new genus of the Hydrocharitaceæ from the Zambezi. The freshwater plant discussed was collected in the River Zambezi, at its confluence with the River Linyanti, at Kazangula, above Livingstone, in Rhodesia. It was growing, staminate plants here and pistillate plants there, on the water-margin of a reed swamp, in water about three metres deep. Apart from the flowers, the whole plant was submerged. The petals are broad; the stamens number twelve, and are of four different sizes; six staminodes, three large filament-like ones and three small scale-like ones, occur in the pistillate flower. Moreover, the new plant is remarkable by its elongate and ligulate leaves, its elongate and terete peduncles, and its cylindrical and monophyllous spathes all covered with soft conical projections. The plants appear to be identical with the type-specimen of *Boottia muricata* Wright.

PARIS.

Academy of Sciences, Jan. 7.—A. Lacroix: The existence of tectites at Cambodia: their morphology. A résumé of the results of the examination of 1750 specimens, giving an account of the shape, fracture, and markings. The question of origin is reserved for later discussion.—E. Fichot: The extension of the method of geographical engineers to terms of the fourth order.—A. Stodola was elected *correspondant* for the Section of Mechanics, and William Bowie *correspondant* for the Section of Geography and

Navigation.—**Paul Delens**: Spherical operations and paratactic congruence.—**Ch. Bioche**: Ruled surfaces having skew cubics for asymptotes.—**V. Smirnoff**: The limit values of analytical functions.—**Soula**: The comparison of various theorems on Taylor's series.—**O. D. Kellogg** and **Florin Vasilesco**: Contribution to the study of the capacity and of Wiener's series.—**A. Demoulin**: A class of congruences.—**Jules Drach**: The transformation of partial differential equations of the second order by the explicit use of the characteristic variables of Ampère.—**Arnaud Denjoy**: A class of analytical functions.—**Alexandre Kovanko**: The approximation of generalised nearly periodic functions.—**A. Gay**: The slow, non-permanent movement of any cylinder in a viscous incompressible liquid.—**Ernest Esclangon**: Experiments in optical reflection and the asymmetry of space.—**Ludovic Gaurier**: Limnological studies in the French Pyrenees.—**Th. De Donder**: The photonic field and the relativist generalisation of the undulatory mechanics of Dirac.—**A. F. Joffé** and **A. N. Arsénieva**: Experiments on the polarisation of electronic waves. The negative results from these experiments concerning polarisation either by reflection or by the magnetic field are in full agreement with the undulatory theory of matter developed by C. G. Darwin and by J. I. Frenkel.—**J. Frenkel**: The impossibility of polarising the cathode rays by reflection.—**Henri Gutton**: The properties of ionised gases in high frequency fields.—**Jean Thibaud**: The effect of periodic concentration and expansion produced by a longitudinal magnetic field on a bundle of slow electrons. The effects produced on the trajectory of a bundle of slow electrons passing through the magnetic field produced by a coil carrying a continuous current resemble those produced on a ray of light passing through a lens, the convergence of which varies continuously.—**Léon** and **Eugène Bloch**: Intercombinations and new terms in the spark-spectrum of sulphur, S II.—**J. Dufay**: The absorption spectrum of oxygen and of ozone in the ultra-violet region.—**V. Dolejšek** and **K. Pestrecov**: The tendency of the values of the discontinuities of the K absorption of the simple bodies.—**Henri Belliot**: Influence of the nature of the fixer on the development after fixing of inverted or solarised photographic plates.—**P. Dejean**: The study of mechanical properties as a means of following the transformations of brasses containing 57·5-63·5 per cent of copper. Crushing tests at varying temperatures up to 900° C. have been carried out and the results given in a graph in which the crushing strength is plotted against temperature for several alloys. The curves show a point of inflection at 475° C. common to all the alloys, and a higher point, 685°-783° C., varying with the composition of the alloy.—**Albert Roux** and **Jean Cournot**: The internal transformations of a copper-aluminium alloy. Details of X-ray studies of a copper-aluminium alloy (90 copper, 10 aluminium) after various kinds of heat treatment.—**Pierre Jolibois**: The application of the theory of Smits to the allotropic varieties of phosphorus. The author contends that this theory, although attractive, is not in accord with the known facts concerning the allotropic varieties of phosphorus. It is regarded as proved that there are four varieties of solid phosphorus, namely, white phosphorus, ordinary red phosphorus, pyromorphic phosphorus and Bridgmann's black phosphorus.—**Clément Duval**: A cobaltic monammine. Werner has classified the cobaltiammines in seven series containing decreasing quantities of ammonia. Up to the present, no example has been known of the type $(Co . NH_3 . X_5) . M_2$. The preparation of a representative of this series is described, sodium cobalti-ammonioborate $(Co(BO_2)_5NH_3)Na_2$.—**R. Locquin** and **V. Cerchez**: Some derivatives of hydantoinacetic acid.—**Max** and **Michel Polonovski**: 3-Chlorotropane and the non-existence of Hesse's bellatropine.—**J. Orcel** and **Gil Rivera**: The microscopic study of the complex copper-silver minerals of Colquijirca (Peru).—**Robert Gibrat**: The variation with direction of the capillary constant of smectic bodies. An application of the Gauss theory of capillarity to smectic bodies.—**Maurice Blumenthal**: The succession and distribution of the tectonic units of the Mediterranean slope of the Betic Cordilleras between Grenada and Gibraltar.—**G. Nicolas**: An endophyte of *Lunularia cruciata*.—**N. N. Kourtiakoff**: The influence of the relief of the soil on fertility.—**P. Mazé** and **P. Evens**: Chlorosis in cultures on land under sewage irrigation: its cause and cure. This can be remedied by addition of iron salts.—**Harald Okkels**: The existence of a morphological specialisation at the level of the vascular pole of the renal glomerule in the frog.—**J. André Thomas**: The reactions of grouped living beings. The action of some alkaloids on *Convoluta Roscoffensis*.—**F. Holweck**: The production of monochromatic X-rays of great wave-length. Quantitative action on micro-organisms. Study of the action of X-rays of 4-8 A. on the pyocyanic bacillus. The results for rays of 4 A. and 8 A. are shown on separate curves and compared with the calculated curves.—**A. Lacassagne**: The action of X-rays of great wave-length on micro-organisms. The establishment of exact statistics of the mortality of the irradiated bacteria. A discussion of the technique necessary for exact determinations.—**Mme. P. Curie**: The study of the probability curves relating to the action of the X-rays on bacilli. A mathematical discussion of the matter in the two preceding papers.—**S. Mutermilch** and **Mlle. E. Salamon**: The local formation of antitoxins in the cephalo-rachidian fluid. The vasculo-meningeal barrier is impermeable to blood antitoxins formed in the animal organism as the result of the inoculation of anatoxins in the peritoneal cavity. The appearance of antitoxins in the cephalo-rachidian fluid of animals vaccinated by the intra-meningeal method is due to their local production by cells the nature of which has still to be ascertained.—**Georges Tixier**: The spectrographic verification of the activation of ergosterol under the influence of irradiation by ultra-violet rays. The curve of transmission of the ultra-violet rays and the curve of antirachitic activity, considered as a function of the time of irradiation, are parallel at first, and then deviate from each other as the time increases. The maximum of antirachitic activity does not correspond with the minimum transparency.

LENINGRAD.

Academy of Sciences (*Comptes rendus*, No. 23).—**A. A. Belopolskij**: Changes in the spectrum of the star α^2 in the constellation Canes Venatici. Observations of variations in the intensity of certain lines in the spectrum.—**N. Gajevskaja**: Some new pelagic infusoria from Lake Baikal. Descriptions of three new genera and four new species.—**C. Flerov**: The diagnostic characters in the genus *Capreolus* Frisch (fam. Cervidæ). Revised diagnoses of the genus and of its two species, *Capreolus capreolus* (Linn.) and *C. pygargus* (Pallas), the latter with three subspecies.—**J. Gueronimus**: The multiple polynome deviating least from the zero and with two first coefficients given.—**B. Schtylko**: A method of determination of fossil remains of Teleostei. In many cases it is possible to use for the identification of fragmentary fossils of Teleostei the shape and sculpture of scales; several examples are analysed.

Official Publications Received.

BRITISH.

The University of Manchester: The Manchester Museum. Museum Publication 96: Report for the Year 1927-28. Pp. 26. (Manchester.) 6*d*. net.

Proceedings of the Royal Society. Series A, Vol. 122, No. A789. Pp. 369. (London: Harrison and Sons, Ltd.) 12*s*.

Ministry of Health. Treatment of Tuberculosis: Analysis of Work done during the Year 1927 under the Schemes of Local Authorities for the Treatment of Tuberculosis, as shown in the Returns furnished in accordance with Memorandum 37/T. (Memo. 131a/T.) Pp. 7. (London: Ministry of Health.)

Air Ministry: Aeronautical Research Committee. Reports and Memoranda. No. 1167 (Ae. 331): Photographs of Streamers illustrating the Flow around an Airscrew in the Vortex Ring State. By C. N. H. Lock. (T. 2583.) Pp. 4+7 plates. 1*s*. net. No. 1177 (Ae. 341): A Brief Survey of Wing Flutter, with an Abstract of Design Recommendations. By R. A. Frazer and W. J. Duncan. (T. 2592: T. 2635.) Pp. 31. 1*s*. 3*d*. net. (London: H.M. Stationery Office.)

Malta. Annual Report on the Working of the Museum Department during 1927-28. Pp. xx. (Malta: Government Printing Office.)

Journal of the Chemical Society: containing Papers communicated to the Society. December. Pp. iv+3091-3308+x. (London.)

Annual Report of the Indian Central Cotton Committee, Bombay, for the Year ending August 31st, 1928. Pp. ii+118+4 plates. (Bombay.) 2 rupees.

Survey of India. Map Publication and Office Work from 1st April 1927 to 31st March 1928. Pp. vi+19+5 maps. (Calcutta.) 1 rupee; 1*s*. 9*d*.

Union of South Africa: Botanical Survey of South Africa. Memoir No. 12: Botanical Survey of the Springbok Flats, Transvaal. By Ernest E. Galpin. Pp. vi+100+22 plates. (Cape Town: *Cape Times*, Ltd.)

Bothalia: a Record of Contributions from the National Herbarium, Union of South Africa, Pretoria. Edited by Dr. I. B. Pole Evans. Vol. 2, Part 2, November 30th. Pp. 371-474. (Pretoria.) 7*s*. 6*d*.

FOREIGN.

United States Department of Agriculture. Technical Bulletin No. 81: The Hessian Fly in California. By C. M. Packard. Pp. 26. (Washington, D.C.: Government Printing Office.) 5 cents.

Meddelanden från Statens Skogsförsöksanstalt. Häfte 24, 1927-28. Pp. iii+389. (Experimentalfältet.) 8 kr.

Koninklijk Magnetisch en Meteorologisch Observatorium te Batavia. Verhandelingen No. 21: Sea-Surface Temperatures on some Steamer Routes in the Malay Archipelago. By Dr. H. P. Berlage, Jr. Pp. 54. (Weltevreden: Landsdrukkerij.)

Regenwaarnemingen in Nederlandsch-Indië. Negen en veertigste Jaargang, 1927. Pp. ii+131. (Weltevreden: Landsdrukkerij.)

Conseil Permanent International pour l'Exploration de la Mer. Rapports et procès-verbaux des réunions. Vol. 49: Procès-verbaux (juin 1928). Pp. 175. Vol. 51: La pêche littorale sur les côtes de Belgique. Par G. Gilson. Pp. 178. (Copenhague: Andr. Fred. Høst et fils.)

Report of the Aeronautical Research Institute, Tōkyō Imperial University. No. 45: Some Problems of Shocks transmitted in Bars and in Plates. By Katsutada Sezawa. Pp. 83-147. (Tōkyō: Koseikai Publishing Office.) 0.65 yen.

Scientific Papers of the Institute of Physical and Chemical Research. No. 164: Die quantentheoretische Deutung der grünen Nordlichtlinie auf Grund interferometrischer Zeemaneffektmessung. Von L. A. Sommer. Pp. 181-201. 30 sen. No. 165: On the Oxidation of Ferrous Hydroxide in Sodium Hydroxide Solution by Means of Air. By Susumu Miyamoto. Pp. 203-208. 15 sen. No. 166: Anomalous Dispersion and Absorption of Electric Waves (continued). By San-ichiro Mizushima. Pp. 209-231. 35 sen. No. 167: Über das Krötengift; Mitteilung 3: Über giftige Bestandteile des Sekrets der japanischen Kröte. Von Munio Kotake. Pp. 233-236. 15 sen. (Tōkyō: Iwanami Shoten.)

Field Museum of Natural History. Anthropological Series, Vol. 18, No. 1: The Prehistory of Aviation. By Berthold Laufer. (Publication 253.) Pp. 96+12 plates. (Chicago, Ill.)

Proceedings of the United States National Museum. Vol. 74, Art. 4: Two new Nematode Worms from Rodents. By Emmett W. Price. (No. 2749.) Pp 5+2 plates. Vol. 74, Art. 12: A new Polychaetous Annelid of the Genus Phyllodoce from the West Coast of Costa Rica. By Aaron L. Treadwell. (No. 2757.) Pp. 3. (Washington, D.C.: Government Printing Office.)

Anuario del Observatorio Astronómico de Madrid para 1929. Pp. 488. (Madrid: Instituto Geográfico y Catastral.)

Journal of the Faculty of Agriculture, Hokkaido Imperial University, Sapporo, Japan. Vol. 23, Part 1: Chemical Studies on Sex Differences of Proteins in Animals and Plants (Second Report); i. Sex Differences of Muscle-fibre (Sarkolemm); ii. Sex Differences of Muscle Proteins. By T. Tadokoro, M. Abe and S. Watanabe. Pp. 27. (Tokyo: Maruzen Co., Ltd.)

Diary of Societies.

FRIDAY, FEBRUARY 8.

ROYAL SOCIETY OF ARTS (Indian Meeting), at 4.30.—Capt. E. J. Headlam: The History of the Indian Marine.

ROYAL ASTRONOMICAL SOCIETY (Anniversary Meeting), at 5.—Presentation of the Gold Medal to Prof. E. Hertzsprung, for his Determination of the Distance of the Lesser Magellanic Cloud and other Pioneering Work in Stellar Astronomy.

PHYSICAL SOCIETY (at Imperial College of Science), at 5.—L. F. Stanley: The Construction and Calibration of a Sensitive Form of Pirani Gauge for the Measurement of High Vacua.—H. C. Webster: (*a*) Photographic Measurement of the Relative Intensities of the La_1, La_2, La_3 Lines of Silver; (*b*) Spark Satellites of the La Lines of Silver.—Demonstration of a New Instrument for the Rapid and Accurate Determination of the Specific Gravities of Solid Substances, by W. A. Benton.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. R. T. Payne: The Treatment of Varicose Veins and Varicose Ulcers by Injection.

ROYAL SOCIETY OF MEDICINE (Clinical Section), at 5.30.

BRITISH PSYCHOLOGICAL SOCIETY (Æsthetics Section) (at Bedford College for Women), at 5.30.—Dr. H. Lowery: Musical Memory and Rhythm.

MALACOLOGICAL SOCIETY OF LONDON (Annual General Meeting) (at University College), at 6.—Prof. A. E. Boycott: The Œcology of British Land Mollusca.

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 6.—L. A. Legros and others: Discussion on The Profession of the Mechanical Engineer.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at Newcastle-upon-Tyne), at 6.—Dr. G. W. Todd: The Prediction of the Properties of Engineering Materials from their Ultimate Structures.

INSTITUTION OF ELECTRICAL ENGINEERS (London Students' Section), at 6.15.—H. H. Taylour: Electric Welding.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Informal Technical Talk), at 7.—B. C. Wickison: Lantern Slides.

GEOLOGISTS' ASSOCIATION (Annual General Meeting) (at University College), at 7.30.—Prof. A. Morley Davies: Formal Migrations since the Cretaceous Period (Presidential Address).

INSTITUTE OF METALS (Sheffield Local Section) (at Sheffield University), at 7.30.—W. T. Griffiths: Some Recent Developments in Nickel Metallurgy.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—Dr. A. E. Dunstan: Recent Developments in the Art of Oil Cracking (Lecture).

BLACKBURN TEXTILE SOCIETY (at Blackburn Technical College), at 7.30.—S. Kershaw: The Production of Worsted and Mixed Yarns.

TEXTILE INSTITUTE (Lancashire Section) (at Harris Institute, Lancaster), at 7.30.—W. B. Crompton: Some Post-War Changes in Lancashire Cotton Mills.

KEIGHLEY TEXTILE SOCIETY (at Keighley), at 7.30.—K. A. Mountain and A. B. Maclean: Comparative Advantages of Private Plant and Purchased Power.

LEICESTER TEXTILE SOCIETY (at Leicester), at 7.30.—T. A. Holroyd: Hosiery Dyeing Operations.

SOCIETY OF CHEMICAL INDUSTRY (Chemical Engineering Group) (at Royal Society of Arts), at 8.—Prof. W. E. Gibbs: The Rôle of Surface Energy in Chemical Engineering.

ROYAL SOCIETY OF MEDICINE (Ophthalmology Section), at 8.30.—R. F. Moore and Mr. Scott: Clinical and Pathological Report of Bilateral Glioma Retinæ.—R. F. Moore: Cirsoid Aneurysm of the Visual Cortex.—B. Graves: Scleral Illumination.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—C. E. R. Sherrington: Recent Problems of Rail Transport at Home and Abroad.

SATURDAY, FEBRUARY 9.

MINING INSTITUTE OF SCOTLAND (at 79 Grassmarket, Edinburgh), at 3.—Prof. H. Briggs: (*a*) The Mineralogy of Coal; (*b*) The Appearance of Coals, etc., in Ultra-Violet Rays.—J. B. Sneddon: The Mining Congress in Canada in 1927.—*Papers open for discussion*:—Some Impressions of German Mining, D. C. Gemmell and J. Heron.—Tru-lay Wires, Ropes, and Tru-lock Fittings, A. T. Adam.—Pavement Brushing *versus* Roof Brushing, J. S. Frame.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. S. Marchant: Music in Cathedral and Collegiate Churches (I.).

MONDAY, FEBRUARY 11.

CAMBRIDGE PHILOSOPHICAL SOCIETY (in University Chemical Laboratory), at 4.30.—Prof. T. M. Lowry: Configuration of Quadrivalent Atoms.—Dr. F. G. Mann: The Stability of Complex Metallic Salts.—Dr. F. H. Constable: An Apparatus for the Study of Gas Reactions on Electrically Heated Films of Known Area.—C. P. Snow: The Structure of the Nitric Oxide Molecule.

ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge), at 5.—Capt. E. R. L. Peake: The Tavistock Theodolite.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. H. A. Harris: Bone Growth in Health and Disease.

INSTITUTION OF AUTOMOBILE ENGINEERS (Birmingham Centre) (at Queen's Hotel, Birmingham), at 7.—Dr. F. W. Lanchester: Coil Ignition.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Centre) (at Armstrong College, Newcastle-upon-Tyne), at 7.—J. Wright and C. W. Marshall: The Construction of the Grid Transmission System in Great Britain.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS (Associates' and Graduates' Branch) (London and District) (at Borough Polytechnic), at 7.30.—J. L. Kinnell, Jr.: Cast Iron.

MEDICAL SOCIETY OF LONDON, at 8.—Dr. M. McCrea and H. Tilley: Earache.

INSTITUTION OF ELECTRICAL ENGINEERS (Western Centre) (at Bristol).

TUESDAY, FEBRUARY 12.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. J. S. Huxley: Evolution and the Problem of Species (III.).

INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.30.—J. S. Parker and C. A. P. Southwell: The Chemical Investigation of Trinidad Well Waters and its Geological and Economical Significance.

INSTITUTION OF PETROLEUM TECHNOLOGISTS (Students' Section) (at Birmingham University), at 5.30.—H. M. Stanley: The Production of Gaseous, Liquid, and Solid Hydrocarbons from Methane. Thermal Decomposition of Methane, Part I.

INSTITUTE OF MARINE ENGINEERS, at 6.30.—G. J. Scott: The Design and Construction of Electric Auxiliaries for Marine Service.

ELECTRICAL ASSOCIATION FOR WOMEN (at 15 Savoy Street), at 7.—H. de A. Donisthorpe: Radio Progress and its Connexion with the Thermionic Valve.

INSTITUTION OF ELECTRICAL ENGINEERS (North Midland Centre) (at Hotel Metropole, Leeds), at 7.—E. B. Wedmore, Dr. W. B. Whitney, and C. E. R. Bruce: An Introduction to Researches on Circuit Breaking.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—H. M. Cartwright: The Limitations of Colour Photography.
INSTITUTE OF BRITISH FOUNDRYMEN (Lancashire Branch, Burnley Section) (at Municipal College, Burnley), at 7.15.—Mr. Griffiths: Some Aspects of Modern Foundry Practice.
INSTITUTION OF AUTOMOBILE ENGINEERS (Coventry Centre) (at Rover Sports Club, Coventry), at 7.30.—Dr. F. W. Lanchester: Coil Ignition.
INSTITUTION OF ELECTRICAL ENGINEERS (Scottish Centre) (at Royal Technical College, Glasgow), at 7.30.—W. B. Woodhouse: Overhead Electric Lines.
INSTITUTE OF METALS (North-East Coast Local Section) (at Armstrong College, Newcastle-upon-Tyne), at 7.30.—J. E. Newson: Metallurgy of Engineering.
NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Middlesbrough Branch) (at Cleveland Scientific and Technical Institution, Middlesbrough), at 7.30.—G. B. Butler: The Manufacture of Steel as applied to Shipbuilding and Engineering.
QUEKETT MICROSCOPICAL CLUB, at 7.30.—Annual General Meeting.
LIVERPOOL GEOLOGICAL SOCIETY (at Royal Institution, Liverpool), at 8.—Prof. H. L. Hawkins: Revolutions and their Effect on Life (Lecture).
ROYAL SOCIETY OF MEDICINE (Psychiatry and Neurology Sections) (*also on Feb. 14*), at 8.30.—Dr. W. H. B. Stoddart (Psychiatry), Sir James Purves-Stewart (Neurology), and others: Special Discussion on Prognosis and Treatment of General Paralysis of the Insane.
NELSON TEXTILE SOCIETY (at Nelson).—J. Kershaw: Fancy Effect Yarns.
MANCHESTER ATHENÆUM TEXTILE SOCIETY (at Manchester).—E. E. Canney: Economic Question of Vital Importance to the Cotton Trade.

WEDNESDAY, FEBRUARY 13.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS (Annual General Meeting) (at Holborn Restaurant), at 2.30.—J. R. Preston: Presidential Address.—H. G. Cathcart: Water Softening by the Base Exchange Process.
ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. H. A. Harris: Bone Growth in Health and Disease.
ROYAL SOCIETY OF MEDICINE (Surgery: Sub-Section of Proctology), at 5.30.—W. B. Gabriel: Case of Carcinoma of the Rectum Complicated by Enlarged Prostate.—Dr. P. H. Manson-Bahr: Pathology of Bilharzia and Amœbic Dysentery of Colon and Rectum.—R. Maingot: Three Cases of Acute Intestinal Obstruction due to Fecal Impaction.—A. L. Abel: Three Cases of Multiple Cancers of Rectum and Colon.
INSTITUTION OF CIVIL ENGINEERS (Informal Meeting), at 6.—H. P. Gaze: Merits of Alternative Methods of Driving Auxiliaries in Modern Power-Stations.
INSTITUTE OF METALS (Swansea Local Section) (at Thomas' Café, Swansea), at 7.—J. E. Malam: Recent Developments in Rolling Metal Strip and Sheet.
NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Graduate Section) (at Bolbec Hall, Newcastle-upon-Tyne), at 7.15.—F. H. Todd: Ship Trials and their Analysis.
HALIFAX TEXTILE SOCIETY (at Halifax), at 7.30.—G. Shackleton: Weaving of Fancy Cloths.
ROYAL PHILOSOPHICAL SOCIETY OF GLASGOW (at 207 Bath Street, Glasgow), at 8.
ROYAL SOCIETY OF ARTS, at 8.—C. Hooper: The Pollination of Fruit Blossoms and their Insect Visitors.
EUGENICS SOCIETY (at Linnean Society), at 8.—Mrs. M. Hawkes, Dr. Drysdale, and others: Discussion on Democracy and Heredity.
ELECTROPLATERS' AND DEPOSITORS' TECHNICAL SOCIETY (at Northampton Polytechnic Institute), at 8.15.—S. Wernick: The Electrodeposition of Cadmium for Rust Prevention.
INSTITUTION OF MECHANICAL ENGINEERS (Glasgow Branch).—Prof. A. S. Eddington: Engineering Principles in the Machinery of the Stars (Thomas Hawksley Lecture).
TEXTILE INSTITUTE (London Section).—G. A. Rushton and others: Informal Discussion on Identification of Textile Fibres.

THURSDAY, FEBRUARY 14.

IMPERIAL COLLEGE CHEMICAL SOCIETY (jointly with Royal College of Science Mathematical and Physical Society) (at Royal College of Science), at 5.—Prof. G. I. Finch: Electro-metallurgy (Public Lecture).
LINNEAN SOCIETY OF LONDON, at 5.—E. E. Edwards: On the Morphology of the Larva of *Dorcus parallelopipedus* L.—E. Taylor: Exhibition of Lantern-slides of Scottish Plants.—R. S. Bose: Biology of Wood-rotting Fungi.—A. G. Lowndes: Lantern-slides of Edge Island, Greenland: Variation in Arctic Freshwater Entomostraca.
LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5.—Prof. O. Veblen: Generalised Projective Geometry (Lecture).
ROYAL SOCIETY OF MEDICINE (Balneology Section), at 5.—Discussion on Osteo-arthritis:—Dr. R. G. Gordon; Dr. J. A. Thomson: Osteo-arthritis Radiographically Considered.—Dr. T. Hare and Dr. H. Cohen: The Chemical Estimation of Synovial Fluid and Blood Serum of Horses Affected with Chronic Arthritis.
ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15—Sir William Bragg: The Early History of X-rays (III.).
BIOCHEMICAL SOCIETY, BIRMINGHAM UNIVERSITY, at 5.30.—Prof. J. C. Drummond: Problems of Vitamin Research.
INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—W. Cruickshank: Voice-frequency Telegraphs.
ROYAL AERONAUTICAL SOCIETY (jointly with Institution of Automobile Engineers) (at Royal Society of Arts), at 6.30.—A. H. R. Fedden: Air-cooled Engines in Service.
SOCIETY OF CHEMICAL INDUSTRY (Birmingham and Midland Section) (at Engineers' Club, Birmingham), at 7.—D. W. Parkes: Disposal of Ammonia Liquors.
SOCIETY OF CHEMICAL INDUSTRY (Bristol Section) (at Bristol University), at 7.30.—Dr. C. A. Edwards: Some Chemical Aspects of Tinplate Making.
INSTITUTION OF ELECTRICAL ENGINEERS (Dundee Sub-Centre) (at University College, Dundee), at 7.30.—W. B. Woodhouse: Overhead Electric Lines.
INSTITUTE OF METALS (London Local Section) (at 83 Pall Mall), at 7.30.—Some Present-Day Metallurgical 'Tools' and Methods:—Dr. C. J. Smithells: The X-ray Spectrometer.—S. V. Williams: Quantitative Spectroscope Analysis.—H. Wrighton: High Magnification Microscopy.—W. E. Prytherch: Dilatometers.—A. J. Murphy: Preparation of Some Unusual Metallographic Specimens.
INSTITUTE OF METALS (Scottish Local Section, jointly with Institution of Engineers and Shipbuilders, and Institute of British Foundrymen) (at 39 Elmbank Crescent, Glasgow), at 7.30.—Dr. W. Rosenhain: Alloys—Past, Present, and Future.
OPTICAL SOCIETY (at Imperial College of Science), at 7.30.—Dr. D. S. Perfect: An Application of the Interferometer to the Goniometry of Prisms.—Demonstration of Prof. Coker's Photo-Elastic Apparatus (1928 Model) by Adam Hilger, Ltd.
LEICESTER LITERARY AND PHILOSOPHICAL SOCIETY (Chemistry Section) (jointly with Leicester University College Biological Society) (at Leicester University College), at 8.—Prof. E. C. C. Baly: The Photo-synthesis of Carbohydrates from Carbonic Acid.
BRITISH INSTITUTE OF RADIOLOGY, at 8.30.
BATLEY AND DISTRICT TEXTILE SOCIETY (at Batley).—W. F. Vickers: Oils and Wool.
INSTITUTION OF MECHANICAL ENGINEERS (Leeds Branch).—Prof. A. S. Eddington: Engineering Principles in the Machinery of the Stars (Thomas Hawksley Lecture).
INSTITUTION OF MECHANICAL ENGINEERS (Manchester Branch).

FRIDAY, FEBRUARY 15.

GEOLOGICAL SOCIETY OF LONDON, at 3.—Annual General Meeting.
ROYAL ASTRONOMICAL SOCIETY (Geophysical Discussion), at 4.30.—Geophysical Methods in Surveying. Chairman: Sir Gerald Lenox-Conyngham. Speakers: Mr. Broughton-Hedge, Dr. W. F. P. McLintock, and others.
BRITISH INSTITUTE OF RADIOLOGY (Medical Members), at 5.—Informal Discussion on Chest.
ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. H. A. Harris: Bone Growth in Health and Disease.
INSTITUTION OF MECHANICAL ENGINEERS (Annual General Meeting), at 6.—H. J. Ward: Refrigeration on Ship-board.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group—Informal Meeting), at 7.—Discussion on the Stephan H. Tyng Foundation Prints.
JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—E. G. Ritchie: Steam Storage.
ROYAL SOCIETY OF MEDICINE (Electro-Therapeutics Section), at 8.30.—Discussion on Chronic Rheumatism of Joints and Muscles: Diagnosis and Treatment.
ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Dr. E. K. Rideal: Chemiluminescence.
SOCIETY OF DYERS AND COLOURISTS (Manchester Section, jointly with Manchester Section of Oil and Colour Chemists' Association) (at Manchester).—F. Scholefield: The Ostwald Colour System.
SOCIETY OF CHEMICAL INDUSTRY (Glasgow Section) (jointly with all Glasgow Chemical Societies) (at 207 Bath Street, Glasgow).—Prof. G. T. Morgan: Chemical Studies of Coal Tar Products.

SATURDAY, FEBRUARY 16.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. E. Bullock: Music in Cathedral and Collegiate Churches (II.).
EUGENICS SOCIETY (at Rembrandt Hotel, Brompton Road), at 7.30.—Major L. Darwin: The Coming of Age of the Society (Galton Lecture).
PHYSIOLOGICAL SOCIETY (at Birmingham University).

PUBLIC LECTURES.

FRIDAY, FEBRUARY 8.

LONDON SCHOOL OF ECONOMICS, at 5.—C. E. R. Sherrington: Railway Electrification and the Redistribution of Industry.

SATURDAY, FEBRUARY 9.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—H. N. Milligan: Life Beyond the Low-Tide Mark.

MONDAY, FEBRUARY 11.

KING'S COLLEGE OF HOUSEHOLD AND SOCIAL SCIENCE, at 5.15.—Prof. G. S. Gordon: The Lives of Authors.
UNIVERSITY OF LEEDS, at 5.15.—Prof. C. Lovatt Evans: The Principle of Adaptation in Physiology.
UNIVERSITY COLLEGE, at 5.30.—Prof. J. G. Andersson: Archæological Research in China. (Succeeding Lectures on Feb. 13 and 15.)—Dr. J. Bonar: Demography in the 17th and 18th Centuries (Newmarch Lectures). (Succeeding Lectures on Feb. 18, 25, Mar. 4, 11, and 18.)
EAST ANGLIAN INSTITUTE OF AGRICULTURE (Chelmsford), at 7.—Prof. J. A. Hanley: Grassland Management.

TUESDAY, FEBRUARY 12.

IMPERIAL COLLEGE—ROYAL SCHOOL OF MINES, at 5.30.—F. L. Engledow: Plant Breeding. (Succeeding Lectures on Feb. 14, 19, and 21.)
UNIVERSITY COLLEGE, at 5.30.—Dr. G. M. Morant: The Rhodesian Man and his Relationship to other Types of Man.

THURSDAY, FEBRUARY 14.

BEDFORD COLLEGE FOR WOMEN, at 5.15.—J. E. Quibell: Egyptian Architecture.

FRIDAY, FEBRUARY 15.

LONDON SCHOOL OF ECONOMICS, at 5.—C. E. R. Sherrington: Motor Transport and Urbanisation of the Countryside.

SATURDAY, FEBRUARY 16.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Miss I. D. Thornley: Travel and Travellers in the Middle Ages.