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Mineralogy and Crystallography in Cambridge.

THE claims of crystallography to be constituted as a separate department in the University of Cambridge, independent of mineralogy, were fully discussed in the Senate House on March 10. The occasion was the discussion of a report by the Council of the Senate containing recommendations for immediate steps to be taken in the reorganisation of the present Department of Mineralogy, which has been under consideration for the last three years.

This is the second of two important discussions dealing with the problem. The first, held on Jan. 28, 1930, dealt with a report by a Syndicate appointed in May 1928 to consider the position of mineralogy in the studies of the University. This discussion and the report of the Syndicate were the subject of articles in NATURE of July 13, 1929, and March 15, 1930. Taken together, the report and the two discussions afford an interesting outline of the development in Cambridge and the possible future scope of the three inter-related subjects of mineralogy, crystallography, and petrology.

The main problem which confronted the Syndicate in 1928 was to provide for the adequate development of crystallography on one hand and of pure mineralogy on the other. The recommendation was to unite petrology (at present taught in the Department of Geology) with mineralogy, and to create two departments, one of crystallography and the other of mineralogy-and-petrology, the latter to be housed in a new building to be erected near the Sedgwick Museum. This accorded equal treatment to the two proposed new departments, and the recommendations received the unanimous support of the original members of the Syndicate. In the discussion which followed its publication, enthusiastic support was given by mineralogists and geologists to the proposed union of mineralogy and petrology, with the proviso that students taking the subject of mineralogy and petrology should also take the subject of geology.

The report, however, raised questions of increased expenditure, additional accommodation, and rearrangement of the examinations, and it is these practical problems which the Council of the Senate has had to face in framing its recommendations.

The question of the place of the subjects of crystallography and of mineralogy-and-petrology in the examination system seems to be nearing a satisfactory solution. The Natural Sciences Tripos Committee has not adopted the recommendations

of the original Syndicate, which involved the creation of 'half-subjects', but it has proposed an alternative and almost equivalent scheme suggested by the professor of mineralogy.

This scheme, published in the *Cambridge University Reporter* of March 10, 1931, unites the subjects of crystallography and mineralogy-and-petrology proposed by the Syndicate into a single full subject, which would require a course of study extending over two years, with provision in the second year of alternative courses for candidates whose interests may be mainly physical and chemical or mainly geological.

The adoption of this scheme will, it is believed, facilitate the close relations of crystallography with chemistry and physics and of mineralogy-and-petrology with geology, which was one of the main objects of the original Syndicate's report.

On the questions of finance and of laboratory accommodation, no immediate practical solution is in sight, and the Council of the Senate has had to proceed on the assumption that the examination system now before the Senate will be adopted, and that steps to put it into practice must be taken before the present professor of mineralogy retires in October, and without incurring any immediate increased expenditure.

The proposal of the Council is, briefly, to establish a new professorship of mineralogy and petrology, to leave the subject of crystallography for the time being under his care, and to make use of existing accommodation, petrology continuing to be housed in the Sedgwick Museum although administered by the new professor.

It is considered highly desirable that suitable accommodation under one roof be provided for mineralogy and petrology, on the site next to the Sedgwick Museum, as soon as funds for building can be made available. No final recommendation is made on the question of the future housing of crystallography, though the possibility of removing it to the new building with mineralogy is favourably considered.

These recommendations give definite priority to the claims of mineralogy and petrology, and on that ground they were attacked by many speakers in the discussion on March 10.

In coming to its decision, the Council has no doubt taken into account the fact that crystallography has for a century been carefully fostered and well taught in the present Department of Mineralogy, and the assumption that this state of affairs will continue has been abundantly justified by the expressions of opinion of mineralogists and petrologists in the discussions both on the original report and on the present recommendations.

Some of those interested in the wider applications of X-ray crystallography are not so sanguine as to the success of the proposed temporary arrangement. They see in the Council's recommendations a danger that crystallography will be relegated to a position subordinate to mineralogy and petrology, too closely associated with these subjects, deprived of separate representation on the Board of Physics and Chemistry, and driven from its present quarters close to the Cavendish Laboratory to, they fear, the less sympathetic neighbourhood of the Sedgwick Museum.

Sir William Bragg emphasised the great change in the scope of the modern subject of crystallography, which, he said, could now with justice be called the chemistry and physics of the solid body, and bore no more relation to mineralogy than to biology, or physics, or engineering. Sir Gowland Hopkins spoke of the bearing of the X-ray study of crystals on an important line of research in biochemistry; and Mr. Bernal indicated wide application in the fields of chemistry, physics, and metallurgy.

Almost without exception, the speakers were in favour of a separate organisation for crystallography, with accommodation on or near its present site in close proximity to the laboratories of physics and chemistry, and with independent control of a sufficient sum for research work, and representation on the Board of Physics and Chemistry.

Lord Rutherford estimated the initial cost of a separate professorship of crystallography, apart from buildings, at between three and four thousand a year, and he thought if such a department was to be created they must look outside the University of Cambridge for funds. He deprecated the further postponement of a decision advocated by Sir William Pope, and insisted on the necessity of taking immediately such steps as were practicable with the means at their disposal. He thought that they should consider very carefully what could be done with the site adjoining the Cavendish Laboratory, and that they should try to arrange for crystallography to have reasonable support and a connexion with the Faculty of Physics and Chemistry. Mr. T. C. Nicholas, who spoke as a member of both the original Syndicate and of the General Board, said that he saw no reason why these provisions should not be made, The recommendations as regards crystallography were only intended as a temporary measure, and the future of the subject was bound to be considered by the

University before any move to new laboratories was made.

These assurances were repeated in a notice published by the Council of the Senate, and on April 24 the recommendations of the Council were passed unopposed. The discussion made it evident that men of science in Cambridge are fully alive to the need for a central institution for the X-ray study of the solid state, equipped to attack the fundamental problems of the other sciences, The alternative appears to be, as Prof. J. B. S. Haldane remarked, the much less economical establishment of separate X-ray research in the individual departments.

All the new developments which would be made possible by the provision not only of such a department of crystallography, but also of the proposed new laboratories for mineralogy and petrology, will assist not merely purely scientific research but also its application to industry. It should, therefore, not be impossible to adopt the practical suggestion made by Lord Rutherford, and to look outside the University for some at least of those funds the lack of which is holding Cambridge back in fields of research where formerly it led the way.

Rock-Paintings in South Africa.

Rock-Paintings in South Africa: from Parts of the Eastern Province and Orange Free State. Copied by George William Stow. With an Introduction and Descriptive Notes by Dorothea F. Bleek. Pp. xxviii + 70 + 72 plates. (London: Methuen and Co., Ltd., 1930.) 42*s.* net.

GEORGE W. STOW, a native of Warwickshire, went to South Africa at the age of twenty-one, when he entered business and took up the study of geology. His life was passed in eastern Cape Colony, Griqualand West, and the Orange Free State. He became keenly interested in the natives, particularly the Bushmen, and as in the course of his travels he had come across a large number of rock-shelters containing paintings, in 1867 he began to make copies of them. By 1870 he had conceived the idea of utilising his material in a history of the civilisation of the Bushmen as painted by themselves, an undertaking upon which he was engaged from that time forward until his death in 1882. He neglected no opportunity to add to his information about the race. In his later years he availed himself of the assistance of a young prospector who was attached to him.

It is difficult for anyone in Europe to form an adequate idea of what travelling was like in those days of long treks in an ox-cart, and of the difficulties Stow experienced in obtaining paper suitable for his drawings. His name will stand for ever on a heroic page of ethnographical studies in South Africa. He was a real pioneer and truly worthy of our admiration.

It was not Stow's practice to copy the whole of the figures on each rock, but to select what appeared to him most noteworthy. The figures are shown in their exact relationship to one another only when the whole formed a group. The scale is always shown. Stow died before he was able to publish; but a posthumous work appeared in 1906 under the title "The Races of South Africa", in which were a number of fine plates and a mass of interesting information. After his decease, Miss L. C. Lloyd, a well-known authority on the language and folk-lore of the Bushmen, acquired his drawings, but was unable to publish owing to lack of funds. Miss Dorothea F. Bleek, who inherited this material, thanks to the assistance of the Carnegie Trustees, has now published a selection consisting of 72 plates, for which all ethnographers and artists will be deeply grateful. The plates, mostly in colour, are very fine and do honour alike to Stow, to Miss Bleek, and to the publishers.

Miss Bleek tells us that in 1928 she made a special journey to all the localities visited and recorded by Stow. Out of the 72 plates now published, she has been able to locate and identify the subjects of 60. She has assured herself of the accuracy of the copies, and at the same time has noted the ravages of the weather and of man and beast on the paintings, which Stow found in a very different state of preservation sixty years ago. With a scruple that is over-delicate, Miss Lloyd asks our indulgence for publishing the original copies rather than fresh ones; but, as she says, Stow saw the material he copied in conditions that have now vanished for ever. She has, therefore, been content to assure herself of the substantial and adequate accuracy of the copies, and to note in each case the variations due to the hand of time or of the copyist.

Miss Bleek, as everyone knows, is herself an authority on the ethnography, the folk-lore, and the language, or rather languages, of the Bushmen; and it is our good fortune that she should have dealt with them in an introduction. Here then, in the first place, is what she has to tell us of the rock-paintings. They are found particularly, as is only natural, in country in which there are rocks—that is to say, in country of irregular conformation: from

Tanganyika to the Cape, especially the country south of the Zambezi—in the ravines running down the sides of the mountains. The finest paintings and the surfaces on which a number of pictures are closely grouped one upon another are usually found in narrow gorges through which flow the more important streams. The sites in the secondary gorges and on higher ground are less numerous and generally not so rich.

Stow's work does not include copies from all the areas in which paintings have been found, nor, as we have said, did he copy all the drawings in each shelter. Nevertheless, his selection gives a richly documented view of the rupestral pictorial art of the country in which he worked. The fauna figured is abundant and varied. All kinds of antelope are there—above all, the eland, which is figured so often as in the end to become stereotyped. Elephants are numerous, rhinoceros and hippopotamus rather rare; quaggas, zebra, and giraffe are not lacking; of the smaller animals, baboons, jackals, hares, and boars appear occasionally only; among the carnivores, the lion and the leopard are most frequent. In the most recent paintings, oxen, sheep, and dogs, with Bantu herdsmen, take a prominent place and are well rendered. The horse, which was introduced in the last century only, is less successful. It is occasionally shown ridden by Europeans. With the exception of the ostrich and the crane, birds are rare, but there is a number of serpents, principally the python. As for fish, tortoises, and frogs, these appear only in the mythological scenes. Insects, as well as vegetation, are seen only exceptionally. However, it is to be noted, Rhodesia affords a number of examples of trees.

Man, both sexes, and alone or in groups, appears in abundance, and engaged in all sorts of activities, hunting, dancing, fighting, running, and the like. As a rule, the figures are nude; but some are clothed in skins, generally in recent paintings in which Bantus also appear, as well as domestic animals—some of which are European domestic animals. Some of the figures have the head of a bird or a mammal, this occasionally in connexion with the chase, sometimes in connexion with the metamorphoses in which the Bushmen believed. No inanimate objects are represented, if those which are being used by the human figures are excepted. Nor is there any attempt to represent the landscape, unless this interpretation is to be placed on a number of dots which may be a fold or enclosure. Once only a marsh is indicated. Here also we must note that, in Rhodesia, marshes, rocks, and rain are represented frequently. Some symbols are compared by Miss Bleek with those which occur with such frequency in the rock-engravings of the Vaal and the Orange River.

There can be no doubt, according to Miss Bleek, that all these paintings are the work of the Bushmen. Fifty years ago the surviving Bushmen still claimed them as the work of their race. Further, they are not all contemporary. While the oldest pictures of animals are the best, those of men attained greater accuracy as it became necessary to distinguish different races by a more exact presentation of their characteristics.

The colours employed by the artists are red in all shades, yellow, brown, chocolate (ochre and clay), black (charcoal), white (oxide of zinc), rose, blue or blue-grey (phosphatic nodules from the schist), and violet. The pigments were ground.

Miss Lloyd remarks that in case of superposition, the older drawings are often dark red or yellow, a fact which she attributes to the more lasting qualities of these colours. She has noted that the white of the polychromes tends to disappear, and that white is not used in the oldest paintings. I cannot mention these observations without making considerable reservations, as they are, in part, contrary to facts I have observed myself. No doubt they are drawn from localities other than those I have visited. The subject is one which requires for its complete elucidation a prolonged study, which it has not yet received. In any case, according to Miss Bleek, blue, rose, and violet are found only in the later paintings. Further, Miss Bleek has observed, and herein she is in agreement with me, that red figures are superposed on black and vice versa. The distribution of colours in a figure is, as a rule, conventional, but occasionally naturalistic.

The sandstone of the shelters, which are not of any great depth, is, according to Miss Bleek, more often than not fairly friable and scales readily. I would add that elsewhere it is far more resistant. The figures often blend into the background. This does not come out in Stow's reproductions, where the background is conventional. There are also paintings in niches apart and on isolated blocks. The greater number of the paintings are at a medium height. The best preserved are found towards the top, where they are out of the reach of the rubbing of cattle. Trees and vegetation, where there are any, have exercised a protective influence.

How old are the most recent of these paintings? The extinction of the Bushmen may be placed at

ninety years ago in the region of Queenstown, at eighty near Barkly, and at sixty in the Orange Free State and Basutoland. That they knew and understood that the subjects painted were scenes in the history of their own race is established by the following facts. Stow showed some of his copies to the aged members of a Bushman family. They declared, not without emotion, that one was a representation of a dance of their tribe, and they reproduced it with appropriate song accompaniment. In 1870–75, Dr. W. H. I. Bleek and Miss L. C. Lloyd, after learning the language of the Bushmen of whom they were in charge, showed them Stow's drawings, and obtained from them an explanation of them and an assurance that they were the work of their race. Many of the mythical and mythological explanations which appear here with the plates are derived from this source and throw a curious light on Bushman beliefs. It was at about this time that Orpen obtained his information; and it was about 1886 that Maluti, the last artist of the Bushman tribe, was killed at Witte Bergen Colonial Native Reserve, when he was carrying in his belt little horn pots each containing a different coloured paint. Naturally, the Bushmen of the Kalahari, where there are no rocks, are ignorant of the art, as are also those who have been able to survive in captivity or in debasing conditions. In any case, between 1878–80 and 1910 the folk-lore of the race has become quite extinct among the survivors around Prieska.

That some of the paintings are not older than the last century is certain. There are some which show Bantus, the date of whose arrival in certain areas can be fixed with certainty. There are others which represent Europeans dressed in the costume of the time of Queen Victoria. But it is evident that there are some—and those a considerable number—which are much older. At Invani, near Queenstown, Stow noted five layers of paintings superimposed, and as he had learned that the Bushmen did not cover the work of an artist as long as his memory persisted, he concluded that this would give an age of about 500 years for the oldest of the paintings. There are some which are certainly earlier, but Miss Bleek is unable to find any criterion which will establish this as proved fact. She is of the opinion that the disintegration of the rock would not admit of the preservation of paintings of any very great age. Nor does she think it would be possible to rely on the evidence of degeneration in the art towards the end; for there are excellent examples among the most recent paintings, and poor among the most ancient. Large polychrome figures of animals are obliterated by monochromes, or the reverse; there are horses among the polychromes, and monochromes occur at all stages, although the red and orange, offering greater resistance as they possess more lasting qualities, are among the most ancient.

I should like to add a few words on the points raised in the preceding paragraph. While it is true that there are certain rocks which disintegrate rapidly, there are others which show as much power of resistance as those of the rock shelters of eastern Spain, which are of palæolithic date, and of which the paintings show much the same appearance of fossilisation as they do in this region. There are many among these ancient paintings which can be seen only when they are wet. I am, therefore, of the opinion that many are much older than Miss Bleek thinks. Even if the white loses its brilliance, it is still there. On some of the oldest of the pictorial sites in Rhodesia there are whites, and I have seen them in the Orange Free State and at Queenstown. I think that, after long, patient, and widely extended study, it may be possible to arrive at some definite conclusion as to the relative age and chronology of the South African art of rock-painting. Relying on my experience in Europe, I have attempted certain provisional suggestions based upon what I was able to see during my stay in South Africa. I am none the less convinced that the work has still to be done, and that it will be a long business. Further, I am sure that Stow's reproductions for the most part belong to a relatively late stage—perhaps, indeed, very late. The investigation would have to proceed by the study of large natural regions, rather as Mr. Burkitt and, more recently, Dr. L. Frobenius have done.

Miss Bleek has devoted considerable space to the Bushmen race, the only race she considers to have a gift for pictorial art. Before the arrival of the European, they were bounded on the west by the Hottentot and on the north and east by the Bantu races, with whom they were engaged in warfare. Although they belonged to one race, they were differentiated in their languages, their beliefs, and their customs. I would add that, so far as is indicated by the fine models from life in the Cape Town Museum, they showed appreciable differences in physical character. For example, steatopygia does not appear in the southern group. Miss Bleek affirms positively that there were not only several languages, but also several groups of languages, which does not seem to fit in with a strict unity.

The Bushmen lived near water-holes, in groups

of two or three huts. Property in these watering-places was hereditary. Each group had defined hunting grounds, which were also their property, and from which they never wandered ; they ranged freely within its limits, which were sufficiently extensive, moving their huts from one site to another. Sometimes also they lived in rock-shelters.

Their clothing, a cloak or cape (kaross) of antelope skin, seems to have been adopted at a relatively late date and under Bantu influence, as the greater number of the figures in the old paintings are nude. They made use of skins for head covering, with the hair outside, usually in the form of birds' heads or antelope-heads, both for hunting and for ceremonial dancing. They wore bands of leather on their wrists, their arms, the upper part of the leg, and also round the waist. They also wore necklaces of beads made from ostrich shell.

The equipment of the men was confined to a bow, which was small and weak, and winged arrows with stone or bone points and poisoned. In addition they carried a pointed stick with a knob.

The women also carried a stick but without a knob. Near the middle a holed stone was fitted to it to increase the force of the blow in digging. Miss Bleek saw this still in use among old women about the year 1900. Earthen pots served for cooking, and water was carried in ostrich egg-shells. Their other implements of worked stone and bone were few and poor.

The Bushmen, indolent and inhabiting a country rich in game, lived careless of the morrow and enjoyed ample leisure—at least, when they were at peace. A few hours devoted to hunting, collecting roots, gathering wood, and drawing water, left them with half the day to loaf about, to look at the animals, to gossip—of which they did much, about the most trivial happenings of the chase, accompanying their recitals with mimicry and gestures which bore witness to their dramatic gifts. It is out of these circumstances, according to Miss Bleek, that their artistic development was brought to birth ; she does not think that among a people so care-free, living in the midst of plenty under a brilliant sun, we can conclude that magic can have played any great part.

Yet the concept of decoration could not have determined the haphazard distribution of the figures ; and there are too many for it to be credible that they were the product of a love of art. The spirit of emulation between artists must have counted for something. Miss Bleek does, indeed, allow that some of the pictures had a magical object, such as, for example, to induce rainfall ; but this is exceptional. It must not be forgotten, she maintains, how great a part is played among a primitive people by pleasure and the search for pleasure, and games. Her contention must be received with the respect due to so great an authority on the Bushman people. At the same time, even if attention is confined to the descriptions of the plates, there are at least twenty (out of seventy-two) which are concerned with sorcery, dances, or mythical subjects, " Rain-Bull ", etc., which gives quite a good proportion with a bearing on beliefs, traditions, and rites.

H. BREUIL.

Biology of Sex.

The Development of Sex in Vertebrates. By Dr. F. W. Rogers Brambell. (Text-Books of Animal Biology.) Pp. xvi + 261 + 24 plates. (London : Sidgwick and Jackson, Ltd., 1930.) 12*s.* net.

THE title of this book is apt to be misleading, for, as Prof. Brambell explains in his preface, he intends to deal not with the dynamics of sex development, but with the morphology and physiology of the gonads and with the genetics of sex determination. He claims the right of an author to treat the subject as it interests him, and so it is to be expected that the reader may think that emphasis is frequently misplaced.

To anyone who seeks an introduction to sex biology this book will prove a useful guide. It is a competent review of the more recent literature and, so far as a description of the development of the gonads and an account of the cytology of the germ cells are concerned, it is the most satisfactory presentation of fact that has appeared during recent years. Spermatogenesis, oogenesis, and fertilisation are described and discussed most ably, and a concise account of the sex-chromosomes in vertebrates is given. Prof. Brambell does well to exhibit caution concerning the conclusion that the *X* and the *Y* sperm are to be distinguished by differences in head length.

The chapter on the sex-ratio is largely a résumé of the writings of Parkes. In dealing with the question of the origin of the primordial germ cells, the author is concerned mainly with the embryological literature ; but he does not fail to direct attention to the studies of Gerard and Hill and of others which have shown that oocytes can be formed from epithelial elements. He discusses also those experiments in which regeneration of ovarian tissue has been observed after complete oophorectomy. Allen's work on the formation of oocytes during

adult life in the mouse is not mentioned. In the chapter dealing with the ovarian follicle and the corpus luteum, an introduction to the physiology of reproduction is successfully attempted.

The rest of the book—some seventy pages—is devoted to discussions on hermaphroditism, sex reversal, and gynandromorphism. In these, the author does not offer any new point of view, nor does he remove any existing difficulty; but he certainly presents the facts and the problems in a most lucid manner.

The editor of the series is justified in thinking that this book "both usefully sums up existing knowledge and points to places where new knowledge and new research are needed. It should be of service both to research workers and to students interested in the general biology of sex."

F. A. E. CREW.

Modern Conceptions of the Quantum Theory.

(1) *The Principles of Quantum Mechanics.* By P. A. M. Dirac. (The International Series of Monographs on Physics.) Pp. x + 257. (Oxford: Clarendon Press; London: Oxford University Press, 1930.) 17*s*. 6*d*. net.

(2) *Die physikalischen Prinzipien der Quantentheorie.* Von Prof. Dr. W. Heisenberg. Pp. viii + 117 + 2 Tafeln. (Leipzig: S. Hirzel, 1930.) 7 gold marks.

(3) *La Théorie des Quanta.* Deuxième édition. *Les Statistiques Quantiques et leurs Applications.* Par Prof. Léon Brillouin. (Recueil des Conferences-Rapports de documentation sur la Physique, Vol. 18.) Vol. 1. Pp. 192. Vol. 2. Pp. 193-404. (Paris: Les Presses universitaires de France, 1930.) 125 francs.

(1) A YEAR or two ago, developments in the quantum theory were so rapid and ideas were so fluid that it was impossible to write a book which would remain a permanent contribution to the subject.

The theory has at last reached a more stable state, and books by nearly all its originators have recently appeared. In Great Britain we welcome one of the most recent publications by Dirac under the title "The Principles of Quantum Mechanics". The original writings of this author have prepared us for a logical and original mode of approach to the difficult problems in atomic physics. His method has the character of a new physical principle. He bids us throw aside preconceived ideas regarding the nature of phenomena and admit the existence of a substratum of which it is impossible to form a picture. We may describe this as the application of 'pure thought' to physics, and it is this which makes Dirac's method more profound than that of other writers.

New concepts form the basis of the theory, and we must avoid the attempt to interpret them in terms of anything already known; only familiarity with the new concepts will help us. Models in physics have their proper place, but they must be made to occupy it, or they tend to hinder progress. They are, in fact, excellent mnemonics. We must avoid the tendency to construct a mammoth out of bacteria which differ from it only in the order of magnitude. The method described in this book is intended to free us from the limitations associated with the old line of attack.

The language especially suitable for describing phenomena in the new way is the mathematics of transformations, and the book contains much pure mathematics. But the author insists upon the physical nature of what he is describing, and one of the successes of the book is the way in which a very attractive, though sometimes difficult, mathematical notation is always kept in the position of a servant. The reader is introduced to a wide range of application of quantum mechanics, and the book contains chapters on statistical applications, on the theory of systems, on collision problems, and develops the first order equations of the quantum theory.

The discovery of this system of equations is one of the author's greatest achievements; it has begun a new stage in the development of the theory. It is by means of these equations that the 'spin term' has been introduced into the wave equation without any special assumption.

It is, even yet, too early to say exactly along what lines the quantum theory will finally develop. Dirac has contributed largely to the detail of the new theory, but the most important contribution he makes is in the mode of approach; he introduces a new attitude of mind towards the investigation of Nature, and the interest lies in watching the development and progress of his ideas. There can be no doubt that his work ranks as one of the high achievements of contemporary physics.

(2) Still wider and deeper than the cleft between the general theory of relativity and the old Newtonian dynamics is the gap between the former and the new quantum theory. The new principles have profoundly modified our conception of the ultimate working of Nature on the microscopic scale, and, in his little book under the above title, Heisenberg

sets out to give a clear explanation of the implications underlying the new theory. This he does, not merely by the routine of mathematics developed for the solution of problems, but by a detailed discussion of important *Gedankenexperimente* which provide good illustrations of the operation and range of the 'uncertainty principle' and bring out very clearly one of the main points of philosophical interest associated with the new ideas. This is that it is necessary either to abandon the classical conception of causality in space-time descriptions of microscopic phenomena, or to retain the principle of causality at the expense of the space-time description, substituting for it a mathematical description not in space and time.

This book should be read by all interested in modern physics, especially as it is written by one of the pioneers of the new theory.

(3) These two volumes by Prof. Léon Brillouin on the quantum theory are written with a lucidity of expression which is characteristic of the author, and they contain a mass of detail on statistical theories about which there has recently been nothing less than a revolution in thought.

The earlier chapters of the first volume are devoted to a consideration of the classical theory of radiation and to the old form of the quantum theory. Apart from the intrinsic value of the subject matter, it is an excellent introduction to the newer work, and is written in the light of the recent advances. From these earlier chapters we pass to the recent developments due to Bose, Einstein, Fermi, and Dirac with applications to radiation and to the theory of gases.

In the second volume the first chapter deals with the interesting examples afforded by the study of electrons in metals to the new theory. The modern theory of electrical and thermal conductivity, of the Peltier and Richardson effects, and of contact potential are among the fascinating problems treated. One chapter is devoted to the evaluation of electronic mean free path, and in another the treatment of the degenerate electron gas is given.

A glance at the table of contents will show that these are merely a few examples of the subject matter. The present position of the modern electron theory of metals is such as to awake optimism concerning its future. The treatment of these problems by the new methods should arouse the interest of the teacher, who can confidently introduce them to his students, and as advance along these lines is rapid, the research worker must keep abreast of these developments. For both purposes these volumes are to be recommended.

Our Bookshelf.

Ethnologischer Anzeiger: Jahresbibliographie und Bericht über die völkerkundliche Literatur. Herausgegeben von M. Heydrich. Band 2, Heft 4. Pp. 129-200. (Stuttgart: E. Schweizerbart'sche Verlagsbuchhandlung (Erwin Nägele) G.m.b.H., 1930.) 9·40 gold marks.

In the bibliography of which this is a part, it is proposed to cover the literature of ethnography, including folk-lore and religion, from 1924 to 1930, in three volumes. Bibliographical work in anthropology, now more than ever, is a serious undertaking. Here, for example, in dealing with one section of the science only, though certainly the largest, there are more than a thousand entries to cover part only of Africa—from "Lequeux" to the end—and a part of Europe—down to "Pallin" under "Finno-Ugrian Peoples", near, though not quite at, the end of the main heading. Even within these limits, the entries are not complete—English literature is not too well represented, especially under Africa, and the years 1926 and 1927 only are covered. A few entries are archæological rather than ethnographical. A very useful feature of the publication is that some less accessible contributions to anthropological literature, especially those appearing in the eastern European languages, are abstracted.

Each main heading of the bibliography has been entrusted to one or more experts for purposes of compilation. Bibliographical work, however, in anthropology more than in any other science (except perhaps zoology), demands international co-operation if it is to be anything like complete. There are at present in existence a number of bibliographies. For the most part, each one deals with some single aspect of the science. But even so, these specialist bibliographies overlap at times, and none of them is complete. Since the International Catalogue of Scientific Literature ceased publication in 1914, no attempt has been possible in the direction of a full and adequately complete bibliography of anthropology as a whole. It is a matter which might well engage the attention of the Committee for Intellectual Co-operation under the League of Nations.

Biology for Schools: a Textbook suitable for School Certificate and similar Examinations. By Dr. E. R. Spratt and A. V. Spratt. (School Examination Series.) Pp. viii + 403. (London: University Tutorial Press, Ltd., 1931.) 4*s.* 6*d.*

The demand for school text-books of biology is still small when compared with that for text-books in almost any of the generally recognised subjects of the curriculum. It is then a matter for compliment to the publisher who can produce a book of more than four hundred pages, well bound, well printed, and containing an average of more than one illustration per page, for the modest price of 4*s.* 6*d.* The authors have compiled a very considerable amount of useful information, and many of the original drawings (especially those of floral structure) are admirably executed.

At the same time, there appears to have been

little time or opportunity for revision of the text, so that a number of corrections will be required in a subsequent edition. There is no acknowledgment, in the preface, of borrowed illustrations; and though a certain number of these are acknowledged in the text, there remain a few which are not. For example, Fig. 19 is scarcely distinguishable from that of the same subject (mustard seedlings) by Sachs. Fig. 196 bears an equally close resemblance to that of the lungs in Thornton's "Physiology", while in Fig. 215 one recognises the old familiar spotty frog from Sir Arthur Thomson's "Outlines of Zoology". Among the original drawings which will require correction are Figs. 168, 221, 232, 245, and 301. A number of errors also creep into the text. For example, the experiment on p. 36 concludes with the word "absorbed" where "transpired" is presumably intended; the description (as well as the illustration) of the trout on p. 232 will give pain to any honest angler—"scales of calcium carbonate, commonly called chalk", is only part of the heresy. These lapses will, however, be easier to rectify than a tendency which runs throughout the book to hurry from description to description, without a pause to consider or to summarise the broad principles involved.

The Practical Dog Book: with Chapters on the Authentic History of all Varieties hitherto unpublished, and a Veterinary Guide and Dosage Section, and Information on Advertising and on Exporting to all parts of the World; a Comprehensive Work dealing with the Buying, Selling, Breeding, Showing, Care and Feeding of the Dog. By Edward C. Ash. Pp. xxxii + 343 + 44 plates. (London: Simpkin Marshall, Ltd., 1930.) 21*s.* net.

IT is four years since we had the pleasure of reviewing Mr. Edward Ash's magnificent and encyclopædic work, "Dogs: their History and Development", and it is a pleasure to receive another work on the same subject from his able pen.

The present book covers, to a great extent, the same ground as his former one, but in a very much shorter and more concise manner. In addition to a series of excellent descriptions of the various breeds of to-day, with their histories, there are sections which deal with the care and management of kennels in general and their inmates, both in sickness and in health. For those taking up dog-breeding as a hobby or a career, there are invaluable chapters dealing with the transport and export of dogs to foreign countries, with quarantine regulations at home and abroad, and the latest possible information regarding the showing of dogs in every country in the world.

The book is profusely illustrated with a series of beautiful plates. These fall into two groups which form an interesting and instructive contrast. One group consists of the dogs of yesterday, which include not only the dogs of the past century but also dogs from the very beginning of things. The second group is composed entirely of the best specimens of the dogs of to-day.

Mr. Ash has collected together in this work a thousand and one items of information about dogs in general, which should be of the utmost value to anyone concerned in the breeding and exhibition of these animals. To the dog lover and student of history, also, the book should be of the greatest value and interest.

The Origin and Growth of Religion: Facts and Theories. By Prof. W. Schmidt. Translated from the original German by Prof. H. J. Rose. Pp. xvi + 302. (London: Methuen and Co., Ltd., 1931.) 15*s.* net.

IT was a happy idea that urged Pater Schmidt to write this manual for the comparative history of religions, and a still happier one that prompted Prof. Rose to translate it into English. It is based on notes for a year's course of the author's lectures and covers the history of the subject, sketches the various theories, movements, and schools, and gives a brief account of the religions in the order of their appearance. A book of this kind was badly needed, especially for students in England, where ideas about method are apt to be a little nebulous, and where, perhaps, too little attention has been paid to development in theory on the Continent.

Pater Schmidt has based his exposition on his great work "Ursprung der Gottesidee", still in course of publication, and his criticism, especially of Tylor and the English animists and pre-animists, is orientated in accordance with his views on the priority of the belief in 'high gods'. He is less than respectful to the English 'diffusionist' school. It is evident that the author is not fully acquainted with the movement of anthropological thought in England and does not understand the various ways in which it develops. The tone of his criticism of Tylor's alleged silence on the subject of 'high gods' is unworthy. While his health lasted, Tylor neither ignored nor attempted to burke criticism of his views; but he did not rush into print. Unfortunately, the same tone appears, if not so pronounced, in Father Schmidt's criticism of 'Protestant' anthropologists. The only appropriate reply is a *tu quoque*. In neither case is the cause of science advanced. Some of the excellent notes added by Prof. Rose here serve to palliate the defects.

Intermediate Mechanics: Dynamics. By D. Humphrey. (Longmans' Modern Mathematical Series.) Pp. x + 382. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1930.) 10*s.* 6*d.*

THE author of this book has set out to fill, in the case of dynamics, the gap that often exists between the normal senior school course and scholarship work in a subject, and he has succeeded admirably, though, in view of the fact that he does not hesitate to use the methods of the calculus whenever they are helpful, the detailed proof that 60 m./hr. = 88 ft./sec. seems somewhat outside the scope of the book. The arrangement is generally good, and the argument clear; the examples are plentiful and well graded, in many cases being accompanied by excellent notes as to appropriate methods or special difficulties.

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.*]

Composite Nature of Certain Potato Viruses of the Mosaic Group.

IN 1928 some experiments on the transmission of a potato mosaic virus to tobacco revealed the curious fact that needle and aphis (*Myzus persicæ*) inoculation respectively, from the same mosaic-affected potato plant, produced in tobacco symptoms characteristic of the method of infection.[1] The disease produced by the needle has since been shown to be a complex, the constituent viruses of which, for the sake of clarity, will be referred to as x and y, where x represents the virus which forms in tobacco double concentric rings with a central spot, hereinafter referred to as 'ringspot', and y represents the aphis-borne virus, the symptoms of which take the form of a darkening of the green colour of the tissues along the veins.

This phenomenon has formed the basis of further studies carried on since that time, and the following facts which have been elucidated seem worthy of record. By the development of a technique of virus isolation from a complex within the living plant, much evidence has been accumulated that certain potato viruses of the mosaic group are not single entities but are composite in character. This is true of the following, among others—a mosaic from Arran Victory potato, a crinkle from Myatt's Ashleaf, a streak carried without symptoms by Up-to-date, and a streak also carried by Di Vernon. All these diseases have been separated into their constituent viruses by means of the technique which will now be briefly outlined.

The methods of virus isolation used in these studies fall into three groups, and separation was effected in the following ways:

(1) By utilising a selective relationship which exists between the aphis vector *Myzus persicæ* and the tobacco plant.

(2) By the use of what may be called 'filter' plants. A comparative study of the host range of the single virus (y), isolated by means of the insect and of the virus complex ($x+y$), revealed the fact that there were several plants which were susceptible to the ringspot virus (x) but were resistant to the aphis-transmitted virus (y). This fact suggested the possibility of using certain of these plants as filters, and experiment has shown that passage of the whole complex ($x+y$) through such plants removes the aphis-carried virus (y). That the virus y is actually removed by this process is shown by the analysis and synthesis of the complex frequently carried out, and by the fact that the aphis cannot pick up the virus y from a ringspot resulting from passage of the complex through one of these filter plants.

It should perhaps be pointed out that successful filtration by means of these plants is dependent upon the needle-scratch method of infection; grafting transmits the whole complex. Examples of plants susceptible to the virus y isolated by means of the aphis are *Hyoscyamus* sp., tomato, and *Solanum nigrum*; and of the 'filter' plants resistant to this virus, *Datura stramonium* and *Solanum dulcamara* among others. All are susceptible to the ringspot virus x.

(3) By taking advantage of the unequal rates of movement of the constituent viruses within the plant host: (*a*) At the moment of development of primary symptoms in the young plant inoculated with the virus complex. (*b*) In the ageing plant.

By means of this technique it has been possible to analyse in the tobacco plant the virus complexes into their constituent viruses and then to synthesise them. Thus, needle inoculation to tobacco from a streak-carrying Up-to-date potato produced a virulent disease characterised by gross lesions and severe necrosis of the veins with no sign of rings, while aphis transmission from the same plant produced in tobacco the disease y, with the characteristic darkening of the green colour of the tissues along the veins. On passage of the necrotic complex through one of the filter plants referred to, back to tobacco again, the disease took on a ringspot form with numbers of clearly defined double concentric rings, each with a central spot; there was no general necrosis. The primary symptoms of this disease take the form of double rings upon the inoculated leaf. Now, to a number of tobacco plants showing this ringspot was added the virus y, which had been isolated from the complex by means of the aphis. After the usual incubation period the primary symptoms peculiar to the aphis-transmitted virus (y) appeared; following rapidly upon this, the rings lost their regular outline, became filled up and degenerated into irregular necrotic lesions, while a severe necrosis of the veins developed. In a short time the symptom picture was identical in every respect with that of the necrotic disease before the separation had been effected. Further passage through the filter plants again produced the ringspot disease, while the addition to this of the aphis-carried virus (y) once more restored the virulent necrotic picture.

While the majority of the diseases studied are shown by these methods to contain two constituent viruses, there is evidence of a third constituent occurring, notably in a streak and a crinkle. There are also certain cases where only one virus can be isolated, at all events by the present technique, and here it is reasonable to suppose that the disease is a single entity.

As regards the question of the non-transmission by the aphis, of the ringspot disease produced in tobacco by needle inoculation with these potato viruses, the obvious explanation is that the aphis is the selective agent and picks up one constituent only of the complex. There is, however, some evidence which suggests that this is not the correct explanation, but that the tobacco plant itself plays a part as the selective factor. It is hoped to settle this question during the coming season.

Finally, to avoid confusion, it is necessary to state that the ringspot diseases referred to here are quite distinct from one or more ringspot diseases which affect the tobacco plant in Nature.[2] There appears to be no record of the experimental ringspots and necrotic diseases, here dealt with, affecting tobacco in Nature, a fact probably connected with the selective relationship existing between aphis vector and tobacco plant.

It is of interest to record that Valleau and Johnson, in a paper recently received,[3] have also suggested the possibility that *Datura stramonium*, one of the 'filter' plants used in these studies, is resistant to a disease in tobacco called 'veinbanding' by Valleau. This veinbanding occurs naturally in the tobacco fields of Kentucky and is presumably identical with the aphis-borne virus (y) originating in potatoes.

It is evident that future work upon these potato virus diseases must take cognisance of their composite nature.

KENNETH M. SMITH.

Potato Virus Research Station,
School of Agriculture,
University of Cambridge, April 7.

[1] *Ann. Appl. Biol.*, **16**, Nos. 1, 3.
[2] Smith, *Ann. Appl. Biol.*, **18**, No. 1; Wingard, *Jour. Agric. Res.*, **37**, No. 3.
[3] *Kentucky Agric. Exp. Stat. Bull.*, 309.

Anomalous X-Ray Diffraction Intensities.

THE accompanying photographs (Fig. 1) show an interesting example of a case where the relative intensities of the lines in any X-ray spectrum may vary without a corresponding change in atomic arrangement. They are Debye photographs of chromium plated wires obtained under different conditions of electrodeposition. It is seen at once that the intensity of the middle line, the (200) reflection, in comparison with that of the other two lines, the (110) and (211), is as strong as normally it should be in the top photograph. In the second photograph it has become relatively weak. In the bottom photograph it has disappeared entirely.

These intensity changes could be explained in various ways if foreign atoms capable of scattering

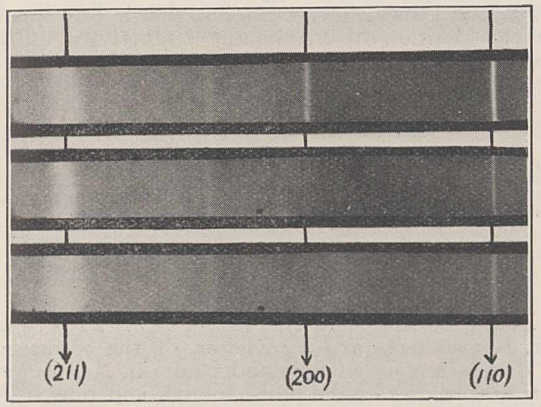

FIG. 1.

X-rays were present to any extent in the deposits. The point of this case, however, is that the metal is apparently free from such impurities. Photographs taken on larger films failed to reveal any appreciable orientation of the grains. The presence of lattice distortion, which also might cause the effect, was considered unlikely because the values of the spacings were found to be constant and equal to those usually accepted for chromium.

The probable explanation follows from the work of Laue on X-ray reflection from crystals of a submicroscopic order of magnitude. The excessive breadth of the lines in the photographs shows that the deposits are composed of such very small crystallites. If those crystals are shaped haphazardly and do not exhibit a preferential habit, all the lines should be broadened in the regular way required by Laue's equations, the broadening being normally larger as the glancing angles increase. But if a majority of the crystals develop a particular form, a flat plate-like shape, for example, or a needle-like shape, then certain sets of planes contain fewer reflecting components, and the resolving power of those planes, in comparison with the others, will decrease until in time they will not produce a spectral line of any degree of visibility. This apparently is what has happened in the case of the (200) line in the photographs. The relative intensities are influenced by the shape of the crystallites.

It is interesting also to note that the type of chromium plating which showed the above effect appeared to be the one characterised by a brilliant lustre. The grey matt type of deposit gave a normal intensity distribution. The full results of the X-ray study of chromium deposits it is hoped to publish elsewhere.

Finally, in view of the fact that the effect occurs with a pure substance, it would seem that the deduction of atomic structure from the relative intensities of the lines on a powder photograph, when the material is in a fine state of subdivision, must be attended with one more complication.

W. A. WOOD.

Physics Department,
National Physical Laboratory,
Teddington, Middlesex,
Mar. 19.

Properties of Dielectrics in Electric Fields.

THE issue of NATURE of Jan. 3 contained a letter from Mr. A. Morris Thomas, of the British Electrical and Allied Industries Research Association, in which, while agreeing generally with the principles in my letter in NATURE of Nov. 22 last, he pointed out that the term 'permittivity' is frequently used now instead of 'dielectric constant'.

I was not unaware of this when writing originally; but the term 'permittivity' was proposed by Heaviside before the electrical nature of matter was discovered, and while answering his immediate purpose, it suggests that the action of the field is through the dielectric, while modern knowledge shows that it is directly on the opposite charges constituting the molecules of the dielectric.

Again, modern work shows also that what is called 'capacity' may arise from at least three different causes, which cannot properly be all comprehended under one term, except for special purposes. In two communications to the *Phil. Mag.* (May 1924 and Jan. 1926) I showed that Maxwell's law was true in the case of 11 out of the 19 non-metallic elements of which the value of ϵ was known, including those most important, and that the same almost certainly would apply to, at any rate, 6 of the remainder. The greatest deviation from equality was about 10 per cent.

On the other hand, for many substances, compounds formed of the above elements, the relative values of ϵ and N^2 widely differ.

As to this, it is now generally accepted that atoms and molecules can be divided into two classes:

(1) *Non-Polar.*—In this class, in an outside field there is repulsion of the nucleus and attraction of the electrons, but no tendency to orientation. Debye calls this the 'distortion'; it is small and any dissipation of energy accompanying it is small also. It agrees approximately with the square of the refractive index.

(2) *Polar.*—In numerous cases the positive and negative charges of the molecules are not symmetrically situated in an outside field: thus, in addition to distortion, they have a moment and tend to be rotated and oriented in line with the field. The capacity of the system is thus increased. This type of capacity, unlike the distortional form, is affected by change of temperature, falling as the temperature is raised and also by increase of frequency.

Both these forms of capacity are due to direct action between the field and the mass of the molecules of the substance acted on. There is, however, a third form of capacity. Ions usually exist in small quantities in dielectrics and constitute polar molecules of the strongest type, with the addition that one pole is stronger than the other; thus, besides orientation, there is a direct pull on the stronger pole of the ion in the direction of the opposite electrode of the field. Thus the capacity of the system is again increased, and at low frequencies this increase may be very large.

In this latter form of capacity the action of the field is on inclusions of electrolytic type, the molecules of which are scattered through the dielectric, and not on the mass of the molecules of the dielectric itself,

as in the two former cases. Thus measurement of capacity at a given frequency may contain all the above components. In any case, by drying or purification, it is necessary to get rid of, or reduce to a small percentage, the third form of capacity before the other two can be confidently isolated.

For technical purposes it is often immaterial to distinguish between the first two forms of capacity, provided the third form can be reduced sufficiently far. But measurement and separation of the first two forms is opening up a new chapter in the study of the attributes of non-metallic matter itself.

The connexion between the properties of matter in an outside field and its other physical properties, however, is not directly through the specific capacity or permittivity, but through the attraction set up between the field and the dielectric, as the result of which the energy is stored, the relative value of which was shown by Boltzmann to be equal to $\frac{\epsilon - 1}{\epsilon + 2}$.

This value must again be corrected for the molecular attraction, which should then be a fairly direct measure of the interatomic attraction after allowance is made for polarity.

At present there is no suitable name for this important quantity, which is closely connected with cohesion and other physical properties of matter (see the above *Phil. Mag.* communication, etc.), nor for the other forms of capacity mentioned above. The time is arriving when it is very desirable that the whole subject of dielectric nomenclature should receive consideration.

This letter is rather belated; but I have been unwell and unable to take up the correspondence sooner.

G. L. ADDENBROOKE.

35 Holland Villas Road,
Kensington, W.14,
April 7.

The Electrical Layers of the Atmosphere.

PROF. MILLIKAN has recently directed attention to a remarkable property of cosmic rays, in his presidential address to the American Association for the Advancement of Science, at Cleveland.[1] He observed that "somewhere in the atmosphere below a height of 15·5 km. the intensity of the ionisation within a closed vessel exposed to the rays goes through a maximum, and then decreases".

Unfortunately, Prof. Millikan did not connect this behaviour with other data which appear to be closely associated with it. In 1925 I directed attention to the fact that three different phenomena pointed to the conclusion that the atmosphere consists of two layers.[2] These zones can be distinguished

(1) *Electrostatically*—the negative zone lying above the positive one.

(2) *Optically*—at sunrise and sunset when the air is very clear and the observer is situated at least $2\frac{1}{2}$ kilometres above sea-level.

(3) *Thermally*—the stratosphere or zone of uniform vertical temperature lying above the troposphere or zone in which the temperature falls with increasing height.

It appears from Prof. Millikan's data that there is still another phenomenon, (4) *the absorption of cosmic rays*, that points to the same conclusion.

It is surely time that geophysicists and meteorologists seriously considered these phenomena. In central Europe the dividing layer is situated at from 7 km. to 12 km. above sea-level, judging from thermal measurements in winter and summer respectively. The most probable explanation appears to me to be that:

(1) Cosmic rays cause ionisation of the air most readily where it has attained a certain pressure.

(2) The movements of the gaseous ions result in gaseous diffusion potential layers, analogous to the liquid potential layers in electrolytes studied by Nernst, the light negative ions rising above the slower and heavier positive ions.

(3) A state of electrostatic strain is set up between the layers, and where sufficiently violent local vertical movements lead to engulfment of portions of the upper zone by the lower, negative thunder clouds surrounded by a concentrated positive sheath may be observed.[3]

The ozone in the air may very possibly be formed in the region of maximum absorption of cosmic rays, since its concentration in the neighbourhood of mountain peaks exceeds that at sea-level.[4] The Heaviside layer of the wireless expert has been placed so much higher than the junction of the two zones (85-95 km.) that it seems possible that it corresponds to the position of maximum conductivity in the negative zone.

WILLIAM C. REYNOLDS.

16 Southern Drive,
Anlaby Park, Hull,
Mar. 31.

[1] NATURE, Jan. 31, 1931, p. 167.
[2] NATURE, Sept. 12, p. 394, and Sept. 26, p. 480.
[3] Reynolds, NATURE, May 30, 1925, p. 836.
[4] Reynolds, *Jour. Soc. Chem. Ind.*, Mar. 28, 1930, p. 168.

Disease in Nature.

IN the discussion in NATURE of April 25 between Mr. Ramsbottom and a reviewer, on the occurrence of disease among animals and plants in Nature, one factor appears to have been ignored, and that is the drastic operation of natural selection in weeding out not merely diseased individuals but also any that carry a weakness reducing their fitness to their environment. When the reviewer argues that parasitism may not be a disease but only an "innocuous *modus vivendi*", is he not begging the question? Relatively innocuous parasitisms persist just in the proportion that the parasite does not enfeeble the host, but no distinction of kind can be made between them and definitely lethal diseases. Animals or plants carrying a 'disease', that is, some lowering of the normal vitality, whether genetic, parasitic, or environmentally caused, are so promptly and thoroughly eliminated that examples will be observed very rarely, because such a very small proportion of individuals of any species are closely examined. We hear, for example, of grouse disease because so many thousands of grouse are shot each year. What about rinderpest and East Coast fever? They have taken heavy toll of African game without any intervention of man.

Man interferes with Nature by taking off the pressure of selection. Our civilisation prides itself on rearing as many as possible of the children born, and from this alone follows the prominence of disease and the relative low ratio of human beings possessed of "exuberant positive health". A native tribe in Central Africa would strike the ordinary observer as exuberantly healthy; the medical officer in close touch with them would tell a different story.

So far as my own observation goes, of plants perhaps more than animals, disease certainly exists in Nature if you look closely for it, but the individuals affected are so immediately suppressed that cases rarely fall under observation. Let me give a parallel which avoids the question-begging term 'disease'. A given species of plant in a certain district may seem to be true to type and free from variation; but bring it into cultivation and grow on all the individuals, then variations immediately disclose themselves. Baur has shown

with *Antirrhinum* that the type from a given locality which, to judge from herbarium specimens, has remained constant for half a century, is yet heterozygous and begins to segregate so soon as seedlings are grown on without natural selection. In Nature, the homozygotes which are produced every generation would seem to fall below the heterozygotes by just that little which ensures their elimination under competition.

A. D. HALL.

John Innes Horticultural Institution,
Merton Park, S.W.19,
April 28.

DISEASE is a point of view. When one organism is living in association with another, the former at the expense of the latter, the balance of metabolism in the latter is always disturbed. The latter may be called diseased while the former is happy in having a plentiful supply of food without much exertion. In Nature such association is constantly going on. A certain system ceases to exist while another comes into being as a consequence. In calling Nature 'healthy' or 'diseased' we are projecting the human point of view into its operations. It seems to me more profitable to try to consider Nature without being influenced by human prejudices.

S. MAULIK.

London, April 29.

Evolution of the Occipital Condyle in the Vertebrata.

THE origin of the occipital condyles of the skulls of vertebrata has not so far been elucidated. They are separate elements from the occipital arch and are ultimately superimposed on the latter, except in fish. The occipital arch is the hinder limit of the skull; and the arch which is the beginning of the vertebral column may be termed the atlas, though it is not homologous in Amphibia and Amniota. Between the occipital region and the atlas there is an intervertebral body which acts as a buffer. An intercalated arch is present on the dorso-lateral sides of this intervertebral body, the existence of which was not previously known; this arch is not complete dorsally and does not enclose the spinal cord; the nerve, spinalis I., passes through or over this intercalated arch.

In fish, the limbs of this intercalated arch lie on the sides, a little above the level of the intervertebral body, so that when a strand of migratory connective tissue cells divides each of the limbs into two parts, those look like zygapophyses between the occipital arch proper and the atlas arch proper. The anterior portion of the intervertebral body, after the division, fuses with the occipital arch to form the occipital condyle. It is concave, as the vertebræ of the fish are amphicœlous.

In Urodela, the intercalated arch lies almost at the same level as the intervertebral body, and when the division of the two limbs of the intercalated arch gives rise to the two condyles, the intervertebral body, instead of being divided, fuses with the anterior end of the atlas, thus forming the so-called odontoid process of the Urodela. In Anura, the intervertebral body, unlike that of Urodela, becomes divided and one part fuses with the atlas and the other part fuses with the occipital region, in consequence of which there is no formation of an odontoid process.

In all Amniota, the limbs of the intercalated arch lie at the sides, a little below the level of the intervertebral body. In reptiles, the anterior part of the intercalated arch, which becomes divided from the posterior part, gives rise to the lateral portion of the occipital condyle, while the intervertebral body fuses entirely with the skull to form the median portion of the occipital condyle. Thus arises the single elliptical occipital condyle. The formation of the occipital condyle of birds is almost like that of the reptiles. In mammals it is almost like that of Anura. In all Amniota, the atlas vertebra has undoubtedly no centrum, but the ventral (anterior) arch completing the floor of the atlas ring is derived from the posterior portion of the intercalated arch, and not from the basiventralia as has been maintained by previous authors.

In reptiles and birds, according to the generally accepted view, the intercentrum represents the united basiventralia. Now, if the centrum of the atlas vertebra fuses with the axis centrum to form the odontoid process, we might naturally expect that the intercentrum belonging to the atlas vertebra should either remain with the dorsal (posterior) arch of the atlas ring or should fuse with the odontoid process of the axis; and in consequence the latter should have two intercentra instead of one, as is actually found in the dried vertebra of the adult. If that be the case, the lower (anterior) portion of the atlas ring cannot be the basiventral element, although it has been generally regarded as such. The details of this investigation will be published later.

HIMADRI KUMAR MOOKERJEE.

University College of Science and Technology,
35 Ballygunge Circular Road,
Calcutta, Mar. 12.

Nitrogen Distribution in Kingston Cheese-Ripening.

A STUDY is being made of the nitrogen distribution in Kingston cheese-ripening. For the determinations, methods evolved and employed by Orla-Jensen, by Barthel, and by others have been drawn upon. In addition, a departure has been made in the applying to this study of the method developed by Wasteneys and Borsook for the fractional analysis of incomplete protein hydrolysates. Determinations were carried out on cheeses of the same 'make' from the day of making to the ninety-eighth day of ripening at intervals defined.

The method of Wasteneys and Borsook has been applied to the study of nitrogen distribution in Kingston cheese-ripening with pronounced success Results obtained when employing the methods of Orla-Jensen and of Barthel may now be complemented and illuminated: for by the application of the Wasteneys and Borsook method can be defined the nature and the amount of the specific protein decomposition fractions—proteose, peptone, and subpeptone—formed as the ripening of the cheese proceeds. Particularly striking is the finding that the difference in the results of the amide nitrogen determinations and the amino nitrogen determinations can be explained when interpreted in the light of data secured by the application of the method of Wasteneys and Borsook. The amide nitrogen curve coincides with the subpeptone nitrogen curve, and the amino nitrogen curve is seen to superimpose itself upon the curve depicting the sum of the subpeptone nitrogen and the peptone nitrogen.

In the light of the nitrogen distribution in Kingston cheese-ripening, the work of Wasteneys and his co-workers on pure proteins and specific enzymes, the classification and definition of the proteases by Willstätter, Waldschmidt-Leitz *et al.*, and data appearing in a study of the casein-splitting abilities of certain lactic acid bacteria in chalk milk culture and of studies on the sugar-fermenting abilities of certain lactic acid bateria as influenced by defined nitrogen sources, we suggest that at the beginning of the ripening of the cheese the protein hydrolysis is of a peptic-like nature, and that this peptic-like proteolysis is to be

attributed not only to the action of the rennet, but also, as our papers about to appear will show, to the elaboration of a peptic-like enzyme by certain lactic acid streptococci. Even within the first twenty-four hours of ripening, the amount of subpeptone appearing suggests that associated with the peptic-like action is a tryptic-like action—a conjecture that again in the light of our cultural studies on certain other lactic acid streptococci is not without merit.

Subject to qualification as further data on the nature of specific enzymes may appear, the results of our study show that after the first few hours of ripening, the proteolytic breakdown in the ripening of Kingston cheese is of an associative peptic-tryptic-like nature.

This study of nitrogen distribution is one of a series on cheese-ripening which is provided for by a research fund established jointly by the Empire Marketing Board and the University of British Columbia. A detailed account of the experiments will appear shortly in the *Journal of Dairy Research*, Cambridge.

BLYTHE A. EAGLES.
WILFRID SADLER.

University of British Columbia,
Vancouver, Canada,
Mar. 27.

Insect Remains in the Gut of a Cobra, *Naia tripudians*.

THE accompanying photograph (Fig. 1) shows the remains of insects belonging to three orders, namely, Rhynchota (Heteroptera-Pentatomidæ), Coleoptera, and Hymenoptera (Formicoidea), found in the gut of a cobra, *Naia tripudians*, brought to us in November 1928. The cobra, which was the black variety with no markings on the back of the hood but with white

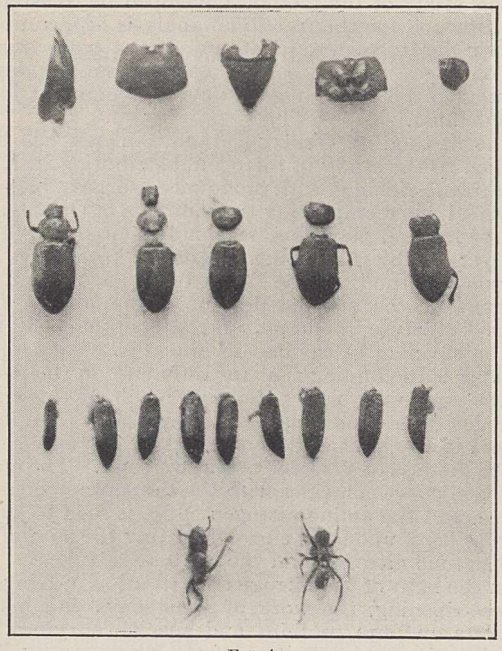

FIG. 1.

patches on the throat, was captured at Banting, in the vicinity of Kuala Lumpur, Selangor, F.M.S. It was not a large specimen, since it measured only 3 ft. $7\frac{3}{4}$ in. in length.

So far as it has been possible to ascertain, records of insects having been devoured by snakes do not appear to be abundant, the only other two which have come to our notice being that of "a small ruddy beetle" found in the gut of *Tropidonotus stolatus* (Wall and Evans, *Journal Bombay Nat. Hist. Soc.*, vol. 13) and of a locust (the species not stated) eaten on one occasion by *Echis carinata* (Wall, *id.*, vol. 18).

The parts of the pentatomid comprise a right hemielytron, pronotum, sternum, scutellum, and pygophor. The ants are ponerines and are capable of inflicting a nasty sting.

We are indebted to Dr. T. A. Buckley, Forest Department, S.S. and F.M.S., for assistance in preparing the photograph.

N. C. E. MILLER.
H. T. PAGDEN.

Department of Agriculture,
Straits Settlements and
Federated Malay States.

The Beginning of the World from the Point of View of Quantum Theory.

SIR ARTHUR EDDINGTON [1] states that, philosophically, the notion of a beginning of the present order of Nature is repugnant to him. I would rather be inclined to think that the present state of quantum theory suggests a beginning of the world very different from the present order of Nature. Thermodynamical principles from the point of view of quantum theory may be stated as follows: (1) Energy of constant total amount is distributed in discrete quanta. (2) The number of distinct quanta is ever increasing. If we go back in the course of time we must find fewer and fewer quanta, until we find all the energy of the universe packed in a few or even in a unique quantum.

Now, in atomic processes, the notions of space and time are no more than statistical notions; they fade out when applied to individual phenomena involving but a small number of quanta. If the world has begun with a single quantum, the notions of space and time would altogether fail to have any meaning at the beginning; they would only begin to have a sensible meaning when the original quantum had been divided into a sufficient number of quanta. If this suggestion is correct, the beginning of the world happened a little before the beginning of space and time. I think that such a beginning of the world is far enough from the present order of Nature to be not at all repugnant.

It may be difficult to follow up the idea in detail as we are not yet able to count the quantum packets in every case. For example, it may be that an atomic nucleus must be counted as a unique quantum, the atomic number acting as a kind of quantum number. If the future development of quantum theory happens to turn in that direction, we could conceive the beginning of the universe in the form of a unique atom, the atomic weight of which is the total mass of the universe. This highly unstable atom would divide in smaller and smaller atoms by a kind of super-radio-active process. Some remnant of this process might, according to Sir James Jeans's idea, foster the heat of the stars until our low atomic number atoms allowed life to be possible.

Clearly the initial quantum could not conceal in itself the whole course of evolution; but, according to the principle of indeterminacy, that is not necessary. Our world is now understood to be a world where something really happens; the whole story of the world need not have been written down in the first quantum like a song on the disc of a phonograph. The whole matter of the world must have been present at the beginning, but the story it has to tell may be written step by step.

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40 rue de Namur,
Louvain.

[1] NATURE, Mar. 21, p. 447.

Rotational Constants of the Iodine Monochloride Molecule.

OUR analysis of the rotation structure of the iodine monochloride absorption bands is now sufficiently advanced to permit of a fairly precise determination of the molecular constants. The region 6482-6837 A. has been measured on plates taken in the second order of a 21 ft. concave grating, and practically all the lines have been allocated to series. The strongest bands in this region are $v''=1$, $v'=8$-12; some bands belonging to the $v''=0$ and $v''=2$ progressions are also present, and there are of course two complete systems,

	B_0'.	B_0''.	α'.	α''.	I_0'.	I_0''.	r_0'.	r_0''.
Cl_2	0·162 cm.$^{-1}$	0·2429 cm.$^{-1}$	0·003 cm.$^{-1}$	0·0017 cm.$^{-1}$	170×10^{-40} gm. cm.^{2}	$113{\cdot}7\times10^{-40}$ gm. cm.^{2}	1·21 A.	0·988 A.
ICl	0·0869	0·1141	0·00115	0·00104	318·4	242·4	2·643	2·306
I_2	0·0291	0·0372	0·00017	0·00012	952	743	3·015	2·663

a strong one due to ICl^{35} and a weaker one due to ICl^{37}. The figures given in the accompanying table refer to the former only.

Each band consists of P, Q, and R branches, the Q being, roughly, twice as strong as the P or R. Some of the branches have been followed up to rotational quantum numbers (K) above 80, but in the neighbourhood of the origin resolution has not been found possible below $K=6$. Nevertheless, the K values may be found without ambiguity, since both initial and final terms conform accurately to the formula $BK(K+1)$ up to $K=30$ at least. Owing to the large difference between the two B's, the R branch turns very quickly (in the neighbourhood of the third line), so that only a small correction (<1 cm.$^{-1}$) will be required to convert previous measurements of unresolved heads to true band origins.

The estimated values of r_0' and r_0'' used by Curtis and Darbyshire [1] in calculating potential energy curves for the ICl molecule are respectively 0·28 and 0·32 A. lower than those now found, but since it is $(r-r_0)$ which appears in the formula used, the necessary correction may be easily made by shifting the origin 0·3 A. along the r axis. The conclusions drawn from the curves depend on their relative position and are not affected by this change.

The rotation constants are given in the table, those for I_2 and Cl_2 being included for comparison. B_0'' is a direct determination, B_0' a least squares extrapolation using the formula $B_{v'}=B_0'-\alpha' v'$, in which v' runs from 8 to 12.

Detailed results based on more extensive measurements will be published later.

W. E. CURTIS.

Armstrong College, Newcastle-upon-Tyne.

J. PATKOWSKI.

University of Wilno, Poland,
April 10.

[1] *Trans. Faraday Soc.*, **27**, 77; 1931.

Raman Spectrum of Solid Nitrogen Peroxide.

IN the course of work on the Raman spectra of solids at low temperatures, we have succeeded in photographing the spectrum of the light scattered by solidified nitrogen peroxide (N_2O_4), at a temperature of about $-80°$ C.

The spectrum is very simple, and consists of one line having a shift of 275 cm.$^{-1}$, and is sufficiently strong to appear as an anti-Stokes as well as a Stokes line, thus confirming the allocation to the particular exciting line (Hg 4358). The material absorbs too strongly in that region for shifted lines excited by Hg 4047 to appear.

X-ray intensity measurements show that at liquid air temperatures the molecule exists as NO_2 and is in a linear form.[1] If this is true at $-80°$ C. also, the Raman spectrum would probably consist of one very strong line, corresponding to the inactive fundamental frequency associated with the vibration of the oxygen atoms symmetrically about the stationary nitrogen atom, together with a very faint line corresponding to the linear active vibration. Such an explanation of the line observed is rendered less probable by the small magnitude of the shift, which might reasonably be more of the order of that due to the corresponding vibration in nitrous oxide (N_2O) (1282 cm.$^{-1}$ in the liquid [2]). Longer exposures are being made in an endeavour to bring up very faint lines.

A. C. MENZIES.
C. O. PRINGLE.

University College, Leicester,
Mar. 31.

[1] Vegard, *Zeits. für Physik*, **68**, p. 184; 1931.
[2] McLennan, Smith and Wilhelm, *Trans. Roy. Soc. Canada*, **24**, p. 197; 1930.

Crystal Structure of Methane.

IN view of the discovery by Clusius of a transformation-point of solid methane at 20·4° K, it was interesting to investigate if there is a change of crystal structure or not. Heuse made a dilatometric examination of the transformation and found the very small volume contraction of 2 per mille, suggesting that the crystal structure is not altered. We have established this as a fact by making two X-ray exposures with solid methane at 21·1° K and 18·5° K respectively. The films were concordant within the limits of accuracy; they can be explained by assuming this structure to be a cubic close-packed one, the side of the elementary cube being 5·88 A. The calculated density 0·52 is in perfect agreement with the value measured by Heuse.

McLennan and Plummer, too, in their X-ray analysis of methane, found a cubic close-packed structure, with 6·35 A. as the side of the elementary cube, however, and calculated density 0·41. Moreover, the relative intensities of the lines we observed differ considerably from those given by these authors.

A more detailed account of this work will be published in the *Proceedings* of the Royal Academy of Amsterdam.

H. H. MOOY.

Leyden,
Mar. 31.

Forestry Research.

I AM very glad to see in NATURE of April 4 the communications from Dr. M. C. Rayner and the Editor on this subject, and I am in cordial agreement with their remarks.

The extensive planting schemes initiated by the Forestry Commission afford a splendid opportunity for fundamental co-operative research on the building up of new forest soils. We know little enough about the soils of our native woodlands, and practically nothing about the conditions induced by planting exotic conifers on heath or grassland in our climate. It is certain that the knowledge acquired by properly planned research will save great sums of money in the future by preventing the waste of large-scale

mistakes. It must be realised that except for two or three species the commercial planting of exotic conifers in Great Britain is still in the experimental stage. It is essential to conduct such experiments with proper scientific control. Forest botany and forest pedology have been seriously and wastefully neglected in the past by those responsible for planting schemes in this country.

I should like to direct attention to a particular opportunity now available. I understand that the future of the Cambridge Forestry School is at the moment under consideration. That school, with proper support, would be able to initiate and carry through precisely the type of work required on the new plantations of the Forestry Commission in Breckland, and there is no other institution so conveniently situated for the purpose. The Cambridge School can never hope to compete with the Oxford School, associated as it is with the Imperial Forestry Institute, in general Imperial forestry work. But Cambridge is in almost an ideal position for undertaking fundamental intensive research on the Breckland forestry problems, and by doing so it will render a service of the first importance alike to science and to practical forestry. It behoves all the authorities concerned to give every possible support to the well-judged scheme of research which has been put forward by Dr. A. S. Watt, the University lecturer in forest botany at Cambridge.

A. G. TANSLEY.

Grantchester, Cambridge,
April 4.

Segregation of Floral Characters in the Wild Oxlip.

IN quite a number of wild oxlip plants, presumably hybrids between the primrose (*Primula vulgaris*) and the cowslip (*Primula veris*), growing in situations where both the latter species abound, I find that the earliest formed flowers are borne on long peduncles of the primrose type, and are succeeded later, on the same plant, by flowers arranged on the umbelliferous type as in the cowslip. Now, the question arises whether this dimorphic arrangement also occurs in *Primula elatior* (Jacq.), the oxlip of East Anglia, which is regarded by some botanists as a distinct mutational variety or species. If this segregation of floral characters is not found in *Primula elatior*, then this fact would favour the supposition that this species is a real mutational form and not a hybrid.

The experience of field botanists working in East Anglia at this season of the year would be helpful in deciding this point. So far, after the examination of some hundreds of plants, I have failed to find this dimorphic floral arrangement in any true primrose or cowslip plant. The question is also important because it bears on the nature of segregation and the essential similarity of this process as it occurs in gametic and somatic cells.

C. J. BOND.

10 Springfield Road, Leicester,
April 19.

The Stimulation of Spermatozoa by Drugs.

I HAVE for some years been investigating the action of drugs on mammalian spermatozoa, under the auspices of the Birth Control Investigation Committee. Finding that certain drugs seemed to stimulate sperms to higher activity, I have recently made a special study of this problem. I have used guinea-pig sperms taken from the epididymis and suspended in a glucose-saline fluid buffered at about *p*H 8. Sperms are so active when first suspended in this fluid that the effect of stimulating drugs is not obvious. In these experiments the sperm suspensions were allowed to remain for 5–8 hours at the temperature of the body before the addition of the drug. After 5–8 hours, the activity of the sperms was markedly reduced. The drugs were tested at concentrations in the series 1, $\frac{1}{4}$, $\frac{1}{16}$, $\frac{1}{64}$ per cent, etc.

Strychnine hydrochloride was found to have a marked stimulating effect at $\frac{1}{16}$, $\frac{1}{64}$, and $2\frac{1}{16}$ per cent, especially at $\frac{1}{64}$ per cent. For practical purposes such a poisonous substance as strychnine is to be avoided, even in minute quantities. Brucine hydrochloride was therefore tried, since its pharmacological properties are similar, while it is only about one-eighth as poisonous. It was found to stimulate sperms markedly at $\frac{1}{4}$, $\frac{1}{16}$, and $\frac{1}{64}$ per cent, especially at $\frac{1}{16}$ per cent. At this concentration brucine hydrochloride has approximately the same stimulating effect on sperms as $\frac{1}{64}$ per cent strychnine hydrochloride, yet it is only about half as poisonous. Brucine therefore seems preferable for practical use. Chloral hydrate was also found to stimulate sperms at $\frac{1}{16}$ per cent, but far less than brucine and strychnine.

It is hoped that this discovery may find practical application in medicine and agriculture, whenever sterility is due to inactivity of sperms. Perhaps its most obvious application is in cases where sperms have been sent long distances for artificial insemination, and are found to be less than normally active on arrival at their destination. Further experiments along these lines are about to be undertaken.

JOHN R. BAKER.

Department of Zoology and
Comparative Anatomy,
University Museum, Oxford,
April 20.

Geodesy in India.

ON page 170 of NATURE of Jan. 31, 1931, appears an article entitled "Geodesy in India", by G. T. McC., being in the nature of a review of Geodetic Report, vol. 5, of the Survey of India. May I correct a small misapprehension into which the reviewer has fallen ?

In the sixth paragraph, reference is made to a decision "to re-map at least a portion of the Dependency". This is not the intention. The areas with which the Survey of India is concerned have been divided into a limited number of overlapping zones of 8° of latitude, to meet the military requirements. In certain areas the latitude and longitude of fixed points have been converted into the corresponding 'grid' co-ordinates and in some cases the grid lines have been or will be surprinted on the maps. But there is no general question of re-mapping at all.

The width of 8° of latitude results in a variation in scale of about 1/400 or 1/800 from the average scale; and for the object in view this has been accepted as negligible. However, in this orthomorphic projection it is a simple matter to apply a scale further varying with the latitude; and were this done, a much wider zone than 8° zone would give rise to little trouble or embarrassment. The gain in increasing the zone width is of course reduction both in number of changes from one grid to the next and the consequential need for duplication in areas of overlap.

J. DE GRAAFF HUNTER.

Survey of India,
Geodetic Branch Office,
Dehra Dun,
Mar. 12.

Cytological Theory in Relation to Heredity.*

By Dr. C. D. DARLINGTON.

THE chromosome theory of heredity, by relating chromosome behaviour with the phenomena of inheritance, has obviously made it possible to apply the cytological method to the study of inheritance. With this profitable field before them, geneticists and cytologists have not hesitated to draw conclusions in the one field from observations made in the other, but in order to do so they have had to apply certain rules of interpretation. Their method has naturally been to assume, so far as possible, a direct relationship between cytological and genetical observations. The geneticist has therefore not only assumed that the material of every part of the chromosome has a specific genetic effect, which is a widely verified assumption; but also that the capacity of the chromosome for variation is equally specific, so that it is possible to refer to hereditary differences and to particles of chromosome alike as 'genes'. This second assumption is also widely verified; but it is subject to serious exceptions in that two different kinds of change have been shown to befall the same particle, namely, internal change and external change such as loss or re-arrangement. This constitutes no primary objection to the theory of the gene but rather indicates a necessary enlargement of its scope.

Cytologists, on the other hand, in translating their observations into genetical terms, have sought to apply the chromosome theory to the interpretation of meiosis. With the help of the simple rule that the pairing of chromosomes is a criterion of their relationship, they have set to work to examine meiosis in hybrids and in ring-forming plants (such as various species of *Œnothera*). The results of these studies have been confusing because investigators have not first examined the principles they were applying to see if they were indeed principles or merely empirical rules of special derivation and therefore of limited application. We now have evidence by which to test them.

Meiosis consists in the occurrence of two successive divisions of a nucleus in the course of which the chromosomes divide once instead of twice as they would in two ordinary mitoses. Where the distribution of the chromosomes is regular, the four daughter nuclei therefore have half the number of chromosomes of the parent nucleus (Fig. 1).

At the first division, the chromosomes come together in pairs, and a whole chromosome of each pair passes to one pole to divide at the second division of the nucleus. To express this comparatively with regard to mitosis, we may say that while two half-chromosomes (or 'chromatids') are associated in pairs at a mitosis, four are associated at the first metaphase of meiosis. A numerical reduction in the chromosomes must be attributed directly to the lack of any splitting of the chromosomes in the interval between the two divisions of the nucleus such as ordinarily occurs. But this is readily related to the fact that each chromosome is already split into the two chromatids which have passed together to one pole. This in turn is related to the pairing of the chromosomes.

It has therefore seemed natural (since 1890) to regard the essential difference between meiosis and mitosis as consisting in the pairing of the chromosomes. Since different pairs of chromosomes pass at random to the two poles (so that A_1-A_2 and B_1-B_2 may give daughter nuclei A_1B_1 and A_2B_2 or, equally, A_1B_2 and A_2B_1), and since the chromosomes are qualitatively differentiated, it follows that those which pair and pass to opposite poles must be similar if meiosis is to yield similar reduced nuclei (Boveri). Clearly, likeness is a condition of pairing. But since the chromosomes that pair can be seen to be morphologically alike and therefore to be corresponding structures derived (so far as observation then showed) from opposite parents (Montgomery), it seemed enough to say that this pairing was due to the likeness of the chromosomes. An 'incipient' association is often to be seen at mitosis in the somatic cells. Perhaps, therefore, meiosis was the final step in the sexual process in which the maternal and paternal elements at last united.

Such is, in a general way, the 'explanation' of meiosis that is current to-day. To be sure, we now know that the association cannot be attributed to an attraction between chromosomes derived from opposite gametes, since pairing has been found in meiosis in parthenogenetic organisms,[1, 2] and very often between chromosomes derived from the same gamete in polyploid plants. It may also be objected that this is merely to explain *ignotum per ignotius*. But it is still taken to be a satisfactory basis for cytological, genetical, and evolutionary deduction. Incompatible observations are freely ascribed to 'mechanical' or 'physiological' conditions.

There are many recent observations of this kind. There are tetraploid plants (such as *Primula sinensis*[3]), the nuclei of which contain four identical chromosomes of each of the twelve types that are represented twice in the diploid. These chromosomes usually associate in fours at meiosis, as they would be expected to do if likeness were the sole condition of pairing. But nearly always one, two, or three of these groups fail to be formed and their chromosomes appear merely paired. This is not explicable on the affinity theory. The chromosomes should be either *all* in fours or *all* in pairs.

Other observations of the same type are: (1) The occurrence of unpaired chromosomes in triploids, instead of all three identical chromosomes of each type being associated (*Zea*,[4] *Tulipa*,[5] *Lilium*[6]). (2) The occurrence of unpaired fragment chromosomes, although these have identical mates with which they can pair (*Secale*,[7] *Matthiola*,[8] *Tradescantia*[9]).

* Substance of three lectures given at the Royal Institution on Mar. 10, 17, and 24.

The only difference between these fragments and the other chromosomes which pair regularly appears to be their smaller size. If the triploids are examined, it is similarly found that the chromosomes which fail to associate regularly in threes are the small ones (*Hyacinthus*[10]). Therefore, not only *likeness* but also *size* bears some relation to the pairing of chromosomes.

If now we turn to consider the structures of the paired chromosomes at meiosis we find a variety of form that shows, at first sight, neither a rule in itself nor any clear relationship with ordinary mitosis. The two processes must be studied in their development in order to be seen in relationship.

The prophase of mitosis is characterised by a linear contraction of two threads, associated side by side, to become the two cylindrical rods which constitute the metaphase chromosome. At meiosis we find at the earliest stage a difference. The threads observed are single. They soon come together in pairs side by side and reproduce the conditions observed at the prophase of mitosis very closely indeed. But on account of their pairing they are present at this pachytene stage in half the number found at the prophase of a mitosis in the same organism. Evidently, therefore, the single threads at the earlier stage were chromosomes still undivided although in the earliest visible stage in mitosis they have already divided.

After an interval, splits appear in the pachytene thread, separating it into two threads, each of which is now seen to be double. But instead of these splits passing right along the paired chromosomes and separating them entirely, it is found, when they meet, that the double threads that separate in one part are not the same pair of threads that separate in another. The separated pairs of threads therefore change partners, and the points at which they change partners (there are often several distributed along the paired chromosome) are called 'chiasmata'. This stage is diplotene (Fig. 1).

Between diplotene and metaphase there is further linear contraction, and the structure of the paired chromosomes may remain the same in regard to the relationships of the four threads of which they are composed: that is, the chiasmata may remain stationary. But they may undergo a change which consists in the opening out of the loop that includes the spindle-attachment, at the expense of the adjoining loops, as though the spindle-attachments of the chromosomes were repelling one another. In other words, the chiasmata appear to move along the chromosome towards the ends: finally, the chromatids are associated in pairs with changes of partners only at the ends. Such changes of partners are called 'terminal chiasmata', and the frequency of the end-to-end unions at metaphase corresponds with the frequency of the chiasmata seen earlier, when they were still interstitial, in small chromosomes (fragments) which only have one chiasma at most.[11] Further, in organisms with large chromosomes it is still possible to see the change of partner: at the end the association is double; it is between the ends of two pairs of chromatids, not merely between the ends of one pair of chromosomes.

These observations point to the chiasmata being the immediate cause of pairing between chromosomes. How can such a hypothesis be tested? It

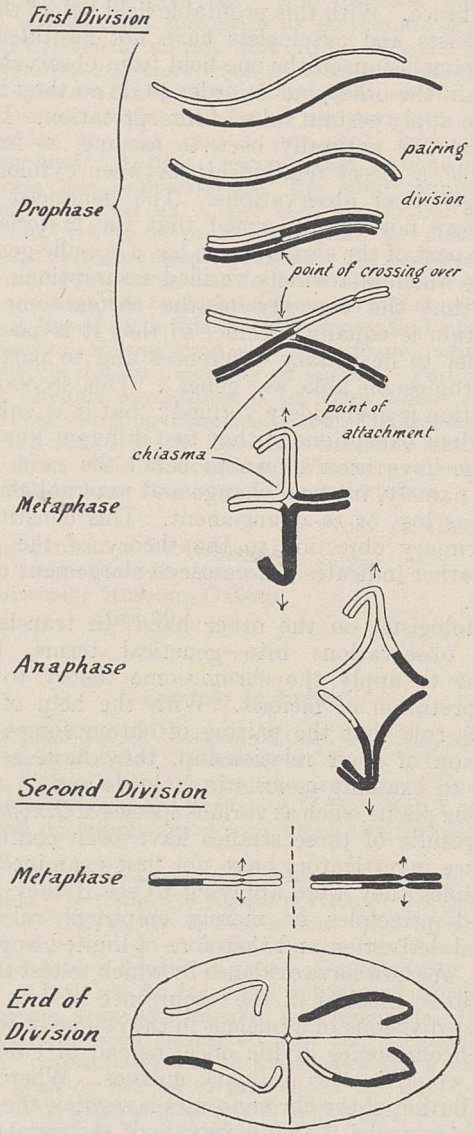

FIG. 1.—Diagram to show the development of one pair of chromosomes at meiosis, and their relationship on the assumption that crossing over is the cause of chiasma formation. The four stages of prophase shown are: (1) leptotene, (2) pachytene before division, (3) pachytene after division, (4) diplotene to diakinesis.

is found that given pairs of chromosomes have a constant range in the number of chiasmata formed. For example, in the *M* chromosome of *Vicia Faba*[12, 11] from 3 to 13 chiasmata are found at the metaphase, with a mean of 8·1. The *M* chromosome, which is much shorter has a range of 1 to 6, with a mean of 3·0. If we suppose that small chromosomes arising by fragmentation have a chiasma frequency proportionate to their length as compared with their larger neighbours, then we can predict from

observations of their size and of the observed frequency of chiasmata in the large chromosomes what their frequency of pairing will be, on this hypothesis. Thus, in the variety "Yellow" of *Fritillaria imperialis* it was found that the chiasma-frequency was 2·58 in the large chromosomes. The fragments were about one-ninth of the length of the large chromosomes. They should therefore have chiasmata in a frequency of 2·58/9 per pair, or 0·29. This means that they should pair in 0·29 cases (neglecting the frequency of one pair forming two chiasmata, which should be slight). They were observed to pair in 0·22 of cases.[11] Here is an example of the type of observation which is susceptible of statistical analysis and supports this hypothesis.

Now, if we admit chiasmata as the condition of chromosome pairing, a considerable simplification is possible in stating the relationship of mitosis and meiosis. Throughout the prophase of mitosis, the threads are held together by an attraction in pairs. The same rule applies to meiosis, for the evidences of failure of pairing of fragments, of odd chromosomes in triploids, and of the four chromosomes of a type in tetraploids all point to the chromosomes having no present attraction at metaphase. They are merely held together by the chiasmata—that is, by the attraction between the pairs of half chromosomes and the exchanges of partners amongst them; and this attraction exists equally at mitosis.

This being so, we must look to the earliest stage of prophase to find the essential difference between the two types of nuclear division. It evidently lies in the time at which the chromosomes split into their two halves. At mitosis, it is probable that this has already happened before the chromosomes appear at prophase. At meiosis, it does not happen until pachytene (possibly at the moment at which the diplotene loops appear). The prophase of meiosis therefore starts too soon, relative to the splitting of the chromosomes. If we consider that there is a universal attraction of threads in pairs at the prophase of any nuclear division, as we see it at mitosis, it follows that this condition is fulfilled by the pairing of chromosome threads when they are still single, and their separation at diplotene when they have at last come to divide. The decisive difference would therefore appear to be in the singleness of the early prophase threads in meiosis. This singleness may be attributed to one or both of two causes: (i) a delayed division of the chromosomes, (ii) a precocious onset of prophase. The second of these seems the more likely explanation, on account of the short duration of the pre-meiotic prophase in some animals. Either assumption would account for the most characteristic of all secondary features of meiosis, namely, the exaggerated linear contraction of the chromosomes, paired or unpaired, if the time relationship of metaphase to the division of the chromosomes remains the same. This hypothesis of precocity[13] may be tested by the observation of a correlation between irregularities in meiosis and (*a*) abnormality in the timing of meiosis, and (*b*) diminished contraction of the chromosomes at metaphase.

The first of these tests is applicable to many organisms with occasional suppression of reduction; the aberrant nuclei enter on the prophase of meiosis either earlier or later than the normal nuclei.[14, 15, 16, 17] When they are too early, it may be supposed that a premature division of the chromosomes has precipitated the prophase; when too late, it may be supposed that the prophase has been delayed. In either case, the chromosomes would no longer be single at early prophase and the condition of their pairing would be lost.

Such a cause of failure of pachytene pairing may be expected to be distinguishable by its effect on the contraction (the second kind of test). For when failure of metaphase pairing is not due to an upset in the timing of prophase but merely to failure of chiasma formation, we might expect normal meiotic contraction; this is the case in maize.[18] Where the prophase has been delayed, we might expect an approach to mitotic conditions; this is the case in *Matthiola*.[19, 20] Other critical evidence in favour of the hypothesis has already been quoted in these columns.[21]

By trying to define in this way the relationship of meiosis to mitosis, we find out what is essential and therefore universal in meiosis, and what is unessential and secondary. Only when the direct interpretation of events in the nucleus is clear (as it now seems to be) can we attempt their genetical interpretation on a satisfactory basis.

Two examples of the genetical interpretation of chromosome behaviour at meiosis are of immediate importance. It has been shown in every organism that has been adequately tested that crossing-over can occur between corresponding parts of the paired chromosomes at meiosis, actually between the chromatids, so that crossing-over in the region between *C* and *D* in a pair of chromosomes *ABCDE* and *abcde* will give four kinds of chromatid: *ABCDE*, *ABCde*, *abcDE*, and *abcde* (Fig. 1). We may suppose that this crossing-over has no relation with anything observable cytologically; that it takes place when the chromosomes are intimately associated at pachytene and has no connexion with later behaviour. This view can only be taken when other possibilities are eliminated. We may also assume that crossing-over has some relationship with chiasmata, either as a cause ('chiasmatypy')[22, 23] or as a consequence, through breakage and reunion of new threads.[10, 9] The last possibility has been eliminated by the statistical demonstration that terminal unions correspond in frequency with interstitial chiasmata,[11] and that the number of terminal chiasmata increases *pari passu* with the reduction of interstitial chiasmata.[3, 4, 20] The first possibility, that the chromosomes fall apart as they come together, and that the exchanges of partners at chiasmata are therefore due to exchanges in linear continuity or crossing-over between the chromatids, has been demonstrated in two ways.

In tetraploid *Hyacinthus* and *Primula* associations occur with such a spatial relationship that

they can only be interpreted as the result of crossing-over.[3, 25] In ring-forming *Œnothera*,[28] chiasmata occur interstitially between a pair of chromosomes associated terminally with two others to give a 'figure-of-eight'. Such an arrangement also can arise only on the assumption of crossing-over. These demonstrations confirm Belling's interpretation of the *Hyacinthus* trivalents, which was not in itself indisputable.[5] Whether the observations are of universal application (the simplest assumption) or not, can only be shown by cytological tests of organisms which have been studied genetically.

A second problem is that of ring formation. Since, on the present hypothesis, the pairing of chromosomes at metaphase is conditioned by the formation of chiasmata at prophase between *parts* of chromosomes of identical structure, it follows that ring formation (where one chromosome pairs in different parts with parts of two others) must always be due to different arrangement of parts, that is, different structure, in the chromosomes contributed by opposite parents.[26, 27, 9] Thus the relationship of the chromosomes of two organisms can always be specified from the observation of the pairing behaviour of the chromosomes at meiosis in the hybrid. It is therefore possible to study differences of such a magnitude as will sterilise a hybrid and are therefore not susceptible of genetical analysis. This method is now being widely applied.

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Landscape at the Royal Academy.

IN "Cape St. Vincent" (669) we have an example of the work of the late W. L. Wyllie in which the revered veteran showed undiminished mastery of his craft. The rush of the Atlantic rollers as they mount and comb on nearing the headland will recall to many, besides the present writer, a notable incident on the voyage from England to the East.

In "Moonlight: Scilly Isles" (90), Mr. Julius Olsson renders with his usual skill one of the most beautiful aspects of the coastal scenery of Great Britain, and the spark of the beacon on the headland both focuses the attention of the eye and adds to the emotional appeal of the picture. In "Sunlight" (130), Sir Hughes Stanton depicts a promontorial town of the Mediterranean coast silhouetted against sea and sky, a picturesque relation of architecture and Nature for which we must seek foreign shores. The austerities of Spanish landscape have attracted Mr. Sydney Lee ("The Ox Cart", 79), Mr. Guy Kortright ("Spanish Cactus", 243), and Mr. Oliver Hall ("A Town of Southern Spain", 414). In the case of several pictures which embody either the golden glow and dark shadows of evening or lurid light and sombre clouds of storm, the artists have enhanced both the height and depth of tone and colour by a frame of black and gold. Notable examples of this judicious device are "The Storm" (80) by Mr. Philip H. Padwick, "Evening in the Mountains" (268) by Mr. William Clarkson, and "Mountains near Beddgelert" (281) by Mr. Oliver Hall.

In the fine study of "Amiens" (258) by Mr. Terrick Williams, the shadowed cathedral owes its immensity to the foreground of small houses, caught by sunlight, on the quay. It is an intriguing fact that impressiveness of size should bear so little relation to that which the astronomer calls the 'apparent magnitude' of an object. A notable example of the dependence of the impression of size upon grouping is afforded by Windsor Castle, which when seen above the houses of the Borough assumes the appearance of a walled town crowning the hill.

In "The Estuary" (301) by Mr. Arnesby Brown, we have one of the characteristic landscapes of the British coast, with fine effects of atmosphere. Towering clouds fill the larger part of the picture, the horizon of the land and sea lying very low in the field of view. Underlying this practice or device of pictorial composition is the singular fact that although the eye is keen to note any lateral divergence from the vertical, it receives no warning sensation of a considerable departure from level outlook. Hence great sky views are not so much determined by the circumstance of there being more sky, as by a natural grouping which lures the eye to an upward outlook.

In "Northleach" (479), Mr. William A. Rixon gives us a faithful picture of Arcadian England; the harvest field and church tower, undulating landscape, and rounded masses of spreading trees, with soft white clouds floating overhead. We may travel the world over but only in England will such a scene be found. This is our particular heritage, which we should cherish and preserve.

In Room X., devoted to Water-Colours and Tempera, Mr. Cecil A. Hunt, in "Glen Brittle, Isle of Skye" (933), has rendered with poetic feeling a

landscape of Britain which stands in greatest contrast to Arcadian England, the rugged range of the Cuillin Hills, pinnacles of dark, volcanic rock, rising above mists hanging in the hollows, where shadows are suffused with the atmospheric colour characteristic of the climate of the Western Highlands.

In the Architectural Room, a perspective drawing of "Sydney Harbour Bridge, Australia" (1401), Sir John J. Burnet and Partners, displays the latest triumph of steel construction, one of those great lattices which, when left unenclosed by masonry, stand out so splendidly against the sunset and the dawn.

The Sculpture Gallery is of particular interest to the scientific community on account of portrait busts, including that of Mr. G. Buckston Browne (1530) by Mr. Charles L. Hartwell, Lord Dawson of Penn (1592) by Mr. Henry Pegram, Dr. Henry S. Wellcome (1513) by Mr. Edgardo Simone, Sir George Makins (1550) by Mr. M. Pownall Bromet, Miss Joan B. Procter (1624) by Mr. George Alexander, and Mr. Allan G. Wyon's fine rendering of the striking features of the late Sir Henry Wickham (1501), pioneer planter of para rubber in India.

VAUGHAN CORNISH.

Obituary.

PROF. A. A. T. BRACHET, FOR.MEM.R.S.

ON Dec. 27 the death took place, after a painful illness of several months' duration, of Dr. Albert Brachet, of Brussels, professor of anatomy and director of the Laboratory of Embryology of the Faculty of Medicine in the University of Brussels. He was a foreign member of the Royal Society and *correspondant* of the Paris Academy of Sciences, and was a distinguished leader in embryological science. He was also well known in circles wider than those of professional embryologists as the author of the admirable "Traité d'embryologie des Vertébrés".

Born at Liège on Jan. 1, 1869, Brachet received his early training in embryology at the hand of Edouard van Beneden. Later he became pupil and assistant to Auguste Swaen. In 1904 he was appointed to the chair in Brussels, where he immediately instilled new life into anatomical study in that University.

Brachet's permanent place in the history of vertebrate embryology will probably rest mainly upon his investigations into the morphological facts of development. His early work with his master Swaen, upon the origin of the mesoderm and vascular system in Teleosts, was followed by a series of valuable investigations upon the early development of Batrachians, and these in turn by researches along corresponding lines upon Ganoid fishes and reptiles. His morphological work bears the impress of a passing phase in the history of embryological science which followed as a natural consequence the flood of uncritical morphology poured out by the enthusiasts of the first few decades after Darwin. The hasty work and ill-balanced speculation of those days naturally brought in its train a spirit of disillusionment as its errors became apparent—with the deplorable incidental result that one of the most fascinating branches of biological science became reduced for the time being to the level of mere fact-collecting.

Brachet was not entirely unaffected by the sterilising spirit of the day. He views the process of gastrulation merely as the attainment of the two-layered condition; the ectoderm and endoderm of the embryo merely as ectoblast and entoblast—without any recognition of that splendid and inspiring idea which appreciates their homology and consequent evolutionary significance. Or again, as regards that other great idea of vertebrate morphology, the protostoma theory, Brachet, while showing intimate knowledge of the actual facts of observation, will have nothing to do with the evolutionary hypothesis which alone provides an explanation of the phenomena observed, and raises them from the level of mere facts to that of constituent parts of a consistent philosophy. Nevertheless, without doubt, Brachet's name will live as one of the important builders of vertebrate embryology.

Like so many of his contemporaries, Brachet became eventually drawn aside from the path of morphology into the territory of experimental embryology. The spirit which animated the work of himself and of his department in later years cannot be better expressed than in his own words, as quoted in the birthday notice contributed on his behalf to NATURE of Jan. 3, p. 41:

(1) ". . . l'analyse de localisations germinales et du déterminisme de la morphogénèse chez les Vertébrés, spécialement les Amphibiens"; (2) ". . . l'étude de la physiologie de la mise en marche du développement et des cinèses de segmentation".

Along such lines, Brachet did much careful and interesting work. It is clear that the reproductive cell of a complicated animal such as a vertebrate, possessing all its potentialities for reproducing the peculiarities of the parent, down even to comparatively trivial details, must have a physiology of immense complexity, far transcending human powers of investigation; and certainly the time is not yet for evaluating finally the achievements of experimental embryology. It is one of the chief merits of Brachet's admirable experimental studies on the egg of the frog that he was able to demonstrate convincingly to what an extent the substance of the egg is already differentiated in its various regions before the act of fertilisation. The further conclusion he reaches as to the active part played by the spermatozoon in readjusting and fixing the localisation of the various organ-forming portions of the egg rests on a less firm foundation.

Brachet was no mere laboratory recluse. Endowed with a lovable personality, a high idealism, and that power of oratory that caused him to be dubbed 'the Jaurès of Anatomy', he wielded great

personal influence among the students of his university. In frequent request to take the chair at sociological meetings, he became the first president of the "Socialist Intellectuals", and at his funeral the Red Flag was prominent. An ardent believer in the 'United States of Europe', he was inspired on one hand by his absolute belief in the socialistic ideal, and on the other by his horror and fear of the recurrence of war.

In the administrative affairs of his university Brachet also exercised much influence. He served his period in the high office of Rector, and his rectorial addresses were marked alike by their eloquence and their lofty and inspiring idealism. It was during this period that he obtained the immense influence and inspired those feelings of affectionate regard that made his untimely death felt as a cruel blow throughout the university community.

Prof. W. D. Zelensky.

The news has just reached Great Britain of the death of Prof. Wladimir Zelensky, professor of zoology and head of the Parasitological Department in the University of Leningrad, which occurred on April 27, 1930, at the age of fifty years.

The late Prof. Zelensky was one of the prominent zoologists of Russia. His investigations were devoted chiefly to the morphology, biology, and systematics of leeches, his most important contribution being the "Investigations on the Morphology and Systematics of the Hirudinea: 1. The organisation of the *Ichthyobdellidæ*" (1915). Lately Zelensky was engaged on a revision of this group of leeches on behalf of the Zoological Station of Naples, and worked on the collections of leeches belonging to various Continental museums. He also prepared for publication the section on leeches for the "Handbuch der Zoologie", by Kükenthal. In his earlier days Zelensky established the phagocytic function of the so-called 'urnæ' in the Sipunculidæ. During the present dearth of biologists of the old school in Russia, the death of Prof. Zelensky will be a great loss to his country.

We regret to announce the following deaths:

Prof. R. S. Heath, formerly vice-principal and professor of mathematics in the University of Birmingham, on April 15, aged seventy-two years.

Prof. W. Valentiner, formerly professor of astronomy in the University of Heidelberg, on April 1, aged eighty-six years.

News and Views.

On May 3, shortly before 9.26 A.M., a sharp local earth-shake was felt, chiefly in the coal-mining district to the north-west of Manchester. The area in which the shock was strongly felt is about 13 miles long and 9 or 10 miles wide, and includes about 100 square miles, but at one or two places outside it was also slightly felt. The shock was strong enough to cause slight damage, such as overthrowing chimney-pots, at Eccles, Irlam-o'-th'-Heights, Patricroft, etc. Tremors were recorded at the Stonyhurst College observatory, beginning at 9 h. 25 m. 56 s. and lasting 40 sec.; but not at the Godlee observatory in Manchester nor at the Bidston observatory near Birkenhead. The small disturbed area (probably less than 200 square miles) and the high intensity near its centre point to a very slight depth of focus, such, for example, as the depth of the coal-seams worked in the district. The longer axis of the disturbed area runs about north-west and south-east, in the direction of the Pendleton or Irwell Valley fault, and the centre of the area lies close to the fault-line. It is probable that the earth-shake was caused by a slip along this fault, and that the slip was precipitated, not by natural causes, as in the Bolton earthquake of Feb. 10, 1889, but by the removal of coal in the neighbourhood of the fault. It is of some interest to notice that the disturbed area of the recent earth-shake almost coincides with that of one, not quite so strong, that occurred on Nov. 25, 1905, and that the places where slight damage to chimneys occurred last Sunday lie close to the centre of the innermost isoseismal of 1905, and to the centres of similar but still slighter shocks on Feb. 27, 1899, and April 7, 1900 (*Geol. Mag.*, vol. 7, p. 175; 1900: vol. 8, p. 361; 1901: and vol. 3, pp. 171-176; 1906).

On May 4 the Huxley Memorial Lecture of the Imperial College of Science and Technology was delivered in the Royal College of Science by Sir Arthur Smith Woodward, who chose as his subject "Modern Progress in Vertebrate Palæontology". A more appropriate subject or a more befitting lecturer could scarcely have been selected for this particular memorial lecture. Sir Arthur, first of all, briefly recapitulated the suggested scheme for the evolution of vertebrates originally proposed by Huxley, who drew up a definite sequence from Hypichthyes (an *Amphioxus*-like ancestor) to the ancestral mammals, and then attempted to find their modern counterparts. In emphasising the modern research work into the question of vertebrate palæontology, Sir Arthur showed how well our modern conceptions fit in with Huxley's ingenious scheme, and how much further modern workers have gone along the same theoretical lines, based on more practical material now available. For example, whereas Huxley could find no modern homologue of the Hypotheria, Sir Arthur was successful in bridging this gap, in the light of modern knowledge. So much has been discovered during recent years that Sir Arthur could not help but make some definite assertions with regard to vertebrate evolution, which only a short time ago he would not have been able to make. For example, amphibians and reptiles are now so closely related by known fossils that their evolutionary sequence cannot be disputed.

As was to be expected from such an authority as Sir Arthur Smith Woodward, the fishes were considered very fully. The result was much information concerning American workers, perhaps to the detriment

of the workers of the Old World along this line of scientific work, who have been able to bring so much to light concerning man. But perhaps it was a happy thought, for, whereas much information is available concerning man, especially since the discovery of *Sinanthropus*, the work on the lower vertebrates comes as a useful complement to it. Here several points of interest and importance were emphasised. For example, the work of Prof. E. A. Stensiö, of Stockholm, has given us a good idea of the Myrichthyes when they dominated the world, whereas their modern counterparts, the lampreys and hag-fishes, are nowhere near enough for this. Bone, too, which undoubtedly was preceded by dentine, in the first place as an exoskeleton, probably followed the dentine more closely than has previously been supposed. Curiously enough, too, the links between groups are nearly always of the smaller types. This, with other observations, leads Sir Arthur to the conception that most probably the same characteristics were arrived at along different channels, that groups began their evolution with definite inherent aims or potentialities which are difficult to describe at present, and that the impetus to evolutionary development was not so much a struggle for existence among the animals themselves as it was between the animals and their environmental conditions.

SIR JOHN RUSSELL gave an analysis of the relation of man to the complicated modern machinery of civilisation, in his Essex Hall lecture entitled "Man and the Machine", delivered on April 30. Sir John pointed out that, until recently, it was the empirical method that has prevailed in our methods of agriculture. Empiricism, however, gave man but an uncertain control of Nature's forces. In agriculture, scientific workers have been successful in discovering the chief factors controlling the growth of plants, and Lawes, the founder of the Experimental Station at Rothamsted, about 1839, first applied this knowledge so as to increase considerably the fertility of the soil and banish the spectre of food-shortage from the world. The application of artificial fertilisers and bacteria specially bred for the purpose, have made better crops possible. Plant diseases have been brought under control, and disasters, such as the terrible potato blight brought into Ireland about a hundred years ago, can now be avoided. The geneticist has, moreover, succeeded in determining many of the characters which decide the nature or properties of plants, their height of growth, time of ripening, etc. The result is that, by selection, new types of wheat have been produced with power of early ripening intensified or capable of growth in areas of subnormal rain-fall. Consequently, arable land has been extended into the cold northern prairies and into the old desert lands, with a great expansion in the wheat potentialities of the world. In 1898, Sir William Crookes declared that the methods and knowledge then current could not long suffice to feed the growing population of the world. Science and practice have advanced, and, in place of famine, wheat is so abundant that the world's granaries hold far more than can be used. Other foods are similarly available more abundantly than ever. In the factories, labour-saving appliances have become so effective that one man can do what it took the labour of several men to do only a few years ago.

WE are in possession, Sir John Russell said, of a new 'machine' that easily achieves things impossible to our fathers and does much of our work for us. The 'machine' calls for specialists. Thus is produced the increasing army of trained men. The cultural effects of the 'machine' on the wider public cannot yet be clearly seen. It tends to foster passive rather than active pursuits; it is thus inimical to the arts of self-expression and self-development. The 'machine' is reducing the demand for human labour, and by no means equally. As a result, a few are overloaded with work and an increasing number find themselves unwanted. This displacement of labour is a new permanent factor in our life as a community, and it must increase in importance as the 'machine' further develops. The contrast between conditions in the country and the towns is striking. The man in the country is much less dependent on the 'machine' than the town-dweller. The very low rate of unemployment in rural England is in striking contrast with that of the industrial regions, showing the greater elasticity of country life as compared with that of the towns, and Sir John Russell is of opinion that the development of country life and country pursuits affords a promising way out of our present difficulties. Our ultimate aim must be to use the machine for the common good.

THE lecture hall of the Institution of Electrical Engineers was crowded on April 30 to hear Prof. W. L. Bragg give the twenty-second Kelvin Lecture. He chose as his subject "The Architecture of Solids", and gave a popular exposition of modern theory which was much appreciated by his audience. He divided solid bodies into three great classes, metals, organic substances, and inorganic substances. Iron, wood, and stone are representative of these classes. Metals differ from the others by the presence of free electrons, the attraction between which and the positive ions gives the structure its stability. The basis of the structure of pure metals and alloys is one of close 'packing', but the radii of the atoms in metals are much greater than those of the ions in crystals. The structures of pure metals are very simple. X-rays have proved of the greatest value in obtaining an insight into the real constitution of alloys. The structure of metals and alloys can be found, but it is very difficult to picture the structure of organic substances. The constitution of inorganic substances is a problem in electrostatics. The stable configuration is that in which the potential energy is a minimum. This enables even the constitution of very complex compounds to be found. When these structures are found, we can study the effects of extension and compression on solids and the effect produced by heating them. Special hypotheses have to be made in several cases, as, for example, when explaining the expansion of metals by heat. Theoretically, heat should be transmitted through salt with the velocity of sound, and rock salt should be stronger than the strongest

steel. Prof. Bragg gave a convincing explanation of why heat travels much more slowly than this in insulating materials. He regards a sheet of mica as simply an electrical condenser. It has great mechanical strength parallel to the sheet and very little perpendicular to it.

THE twenty-first annual May lecture of the Institute of Metals was delivered on May 6 by Mr. William B. Woodhouse, past-president of the Institution of Electrical Engineers. Mr. Woodhouse reviewed the development of power production throughout the world and in particular the important question of the extent to which Great Britain, dependent as it is on coal for power production, can compete with water power in other countries in the production of cheap electricity for metallurgical and other industrial purposes. Electrical methods of treating ores and of producing and refining metals are used to an extent which requires very large amounts of power and is rapidly growing. Electric power is being produced in Great Britain by the consumption of coal at a price which compares favourably with water power in other countries. The great development of water power in other countries and the large amount still unused calls for the most careful consideration of our relative position as a power-producing country. The use of oil fuel, its effect on the production and demand for coal, and the prospects of producing oil fuel from British coal, were also discussed. The progress of electric power supply by a single organisation over a wide area, initiated in England some thirty years ago by the electric power companies, the developments of which have, in the face of great difficulties, provided a general supply of electricity at a low price, led the way to nationally and internationally interconnected systems of supply in all parts of the world, and in Great Britain to the establishment of the 'grid' by the Central Electricity Board. It is practicable to obtain large amounts of electricity from efficient power stations in Great Britain at a price as low as one-fifth of a penny a unit or even less for secondary power or restricted supplies.

IN September 1929, the Government appointed a committee to consider and report upon the desirability and feasibility of establishing one or more National Parks in Great Britain, and with commendable promptitude the Report of the National Park Committee has just been issued (Cmd. 3851. London: H.M. Stationery Office. 2*s*. net). It deals generously with the terms of reference, and covers a wide range of aspects of the preservation of scenery, of fauna, and of flora. The objects to be achieved by a system of natural reserves and Nature sanctuaries in Great Britain are stated to be three-fold: the safeguarding of areas of exceptional natural interest against disorderly development and spoliation; the improvement of means of access for pedestrians to areas of natural beauty; and the promotion of measures for the protection of flora and fauna. The Committee is strongly in favour of the preservation of such areas for the public, and makes suggestions for the extension of planning powers and for the formation of regional committees which would see the necessary arrangements carried through. It distinguishes between national reserves, of interest to the nation as a whole, and regional reserves, selected for their convenience of access from industrial centres, but thinks that at the present stage it would be premature to select specific areas. The variety of opinion with which the Committee had to deal is well and interestingly illustrated in the summaries of evidence which form an appendix to the Report.

THE annual meeting of the members of the Royal Institution, for the election of officers and to receive the report of the visitors for the year 1930, was held on May 1. Lord Eustace Percy was elected president, Sir Robert Robertson treasurer, and Major C. E. S. Phillips secretary. In August last, the Institution suffered the loss of its president (and devoted servant), the Duke of Northumberland, a vacancy filled afterwards by the election of Lord Eustace Percy. The roll of the Institution at Dec. 30, 1930, comprised 944 members. Of 40 members deceased, special reference is made to eight, whose average tenure exceeded fifty years. Lord Balfour had been a member for sixty years. The managers are in the fortunate position of being able to report the completion of the alterations to the building, involving in parts a reconstruction. The house is now fully open to members, and the library books, apparatus, and equipment have been replaced. The Faraday celebrations in September will therefore be held under happy home auspices. Additional cause for congratulation is found in the situation that the efforts of the managers to meet the expenses of the alterations have proved successful. There will be no contingent burden of debt to carry forward. Besides receiving generous donations from immediate friends, the Institution has derived most timely and substantial aid from the Pilgrim Trust.

IT is not the British way to allow a regularly established and accredited organisation to fail; otherwise the Royal Institution would have ceased to function, during earlier generations, in any national sense and conception. The adoption of the new plan of management and activities promulgated in 1810 brought, however, permanent ideals and adherents. Notwithstanding, the managers in those times endured heavy financial trials; still, they held on. In 1814, during the absence of Sir Humphry Davy, "the Institution did little for science, but though poor, it strove to be fashionable" (Bence Jones). It gave "a cold collation" to the Grand Duchess of Oldenburgh on May 23 of that year. The funds were not flourishing, as premised; indeed, many bills were paid out of a special benefaction fund for discharging debts. Somewhat earlier, the managers had refused lectures on physiology and comparative anatomy "because they could not convince themselves that scientific lectures can be given on these subjects without offence to a part of their audience". Varied as the story is, of which present-day managers of the Royal Institution must have ample knowledge, the past fluctuations of

the establishment provide stimulating thought and instruction. Faraday gave his first lecture within its walls in 1824.

A NOTEWORTHY feature of the Safety Week arranged by the National Safety First Association, which is to be held in Leeds on May 11-16, is the chemical session arranged for Tuesday, May 12. This session, at which Dr. E. F. Armstrong, chairman of the Association of British Chemical Manufacturers and of its Works Technical Committee, will preside, is open not only to members of the chemical and allied industries but also to representatives of all firms which are members of the National Safety First Association. The Association of British Chemical Manufacturers has already been responsible for much valuable work in regard to safety in the chemical industry. A series of *Safety Circulars*, giving information on accidents occurring from time to time in chemical industry, and indicating precautions which may be taken to avoid their repetition, as well as a quarterly summary of safety literature, are regular features of the Association's activities. In addition, the Works Technical Committee has already issued Part 1 of "Model Safety Rules for Chemical Works", and a first section of Part 2, dealing with fire and explosive risks.

AT the chemical session on May 12, Mr. J. Davidson Pratt, general manager of the Association, will present a paper on the cleaning and repair of vessels containing dangerous materials. This is a subject of interest to almost every industry, and neglect or ignorance of the precautions to be used in cleaning or repairing containers, particularly those used for organic solvents, has been responsible for numerous accidents, many of which have been fatal. The incidence of such accidents is far from being confined to chemical industry, where the necessary precautions are indeed comparatively well known and observed, and one of the fundamental problems of industrial safety is indeed here encountered—that of securing the dissemination of the safety information in every quarter where it may be of use. The Leeds meeting provides a valuable opportunity for the consideration of an important safety problem, and a good attendance should ensure that the principles to be observed in handling such containers are made known in quarters not otherwise easily reached.

AT a meeting of the International Executive Council of the World Power Conference of 1929 the need for a comprehensive and authoritative survey of current literature on power, fuel, and related subjects was recognised and a sub-committee appointed by the British National Committee considered the suggestion. Its report was unanimously approved at the meeting held in Berlin in June 1930. It was suggested that a bulletin be prepared, with the following recommendations: (1) Each country to abstract its own literature, the abstracts to be in English, French, or German; (2) the abstracts to be indexed in accordance with the Universal Decimal Classification; (3) the arrangement of the abstracts to follow that in use by the Institut international de Bibliographie, to be printed on one side of the paper only, and to be capable of being mounted on 5 in. × 3 in. cards. This last recommendation is a good one, since it allows for either binding annually or a card index system. The first number of this *Power and Fuel Bulletin*, published by the British National Committee, has recently appeared. The abstracts are grouped under four main headings—(*A*) sources (fuel, water, wind), (*B*) generation (steam, electricity, water, mechanical power), (*C*) distribution and storage (steam, electricity, water, gas, oil, pneumatic), (*D*) utilisation. The following organisations are co-operating in the compilation of the bibliography: Fuel Research Division, Department of Scientific and Industrial Research, British Chemical Plant Manufacturers' Association, British Electrical and Allied Manufacturers' Association, Institution of Petroleum Technologists, National Federation of Iron and Steel Manufacturers, and the National Gas Council of Great Britain and Ireland. The *Bulletin* will be published monthly, and the subscription is ten shillings for twelve issues. A copy of the first number and a subscription order form will be sent, post free, on application to the Honorary Secretary, British National Committee of the World Power Conference, 63 Lincoln's Inn Fields, London, W.C.2. The National Committees in Czechoslovakia, Germany, Japan, and Poland have also begun publication, or will do so in the near future.

AN instructive article appeared in the *Times* of May 1, concerning two new research stations, of much importance to the deep-sea fishing industries of the British Empire, which have been founded in Newfoundland and Scotland. The Newfoundland station, which is being set up jointly by the Newfoundland Government and the Empire Marketing Board at Bay Bulls (near St. John's), starts operations this spring. The Torry station, under the Department of Scientific and Industrial Research, and also financed largely by the Empire Marketing Board, has been in existence at Aberdeen for a little more than a year. These two stations represent the latest endeavours to organise and conduct scientific investigations on two great problems with which the modern fishing industries are confronted. Newfoundland, as a great exporter of fish, will be served by the scientific workers at Bay Bulls in the search for a fuller knowledge of the great natural fluctuations in yield of the fisheries for cod and other economically valuable fish; knowledge which will render possible the establishment of an effective intelligence service for recording the movements, quantities, and quality of the fish shoals upon which the fishermen depend. At Torry, on the other hand, efforts are being directed towards the perfecting of methods designed to preserve the catch in the best possible condition as food and in a form which will appeal to the palate of the consumer. Success at Bay Bulls will free the producer from the present trammels of uncertainty in yield, while good work at Torry will facilitate the successful exploitation of far-distant fishing-grounds, and ensure to the consumer a better and more acceptable food commodity.

IT is pointed out, in a recent *Daily Science News Bulletin*, issued by Science Service, Washington, D.C.,

that the route of the proposed Nicaraguan canal lies almost directly across the epicentre of the earthquake that ruined Managua on Mar. 31. That epicentre lies in lat. 11·9° N., long. 86° W., close to the north-western end of Lake Nicaragua. Another shock of similar intensity from the same origin might cause great damage to canal locks and power-houses, or to the canal itself by landslides. It is worth noticing, however, that in all excavations, the intensity of an earthquake is much less than on the surface. This fact has frequently been experienced in railway tunnels and in mines, and even at the bottom of pits 10-18 ft. deep, as was shown by measurements made in Japan about forty years ago by Milne, Sekiya, and Omori (*Trans. Japan Seis. Soc.*, vol. 10, pp. 25-26, 36; 1887, and vol. 16, pp. 19-45; 1892).

ADMIRAL D. W. TAYLOR, U.S.N., and Rear-Admiral Sir Douglas Brownrigg, Bart., have been elected honorary vice-presidents of the Institution of Naval Architects.

AT the meeting of the Royal Society on May 14 there will be a discussion on "Ultra-penetrating Rays". The discussion will be opened by Prof. H. Geiger, of Tübingen, followed by Lord Rutherford and others.

THE centenary of the birth of David Edward Hughes (May 16, 1831) will be commemorated at the Institution of Electrical Engineers on May 14, when a short discourse on the life and work of Hughes will be delivered by Mr. Sydney Evershed.

THE sixteenth Guthrie Lecture of the Physical Society will be delivered by Sir Richard Glazebrook, who will take as his subject "Standards of Measurement, their History and Development". The lecture will be delivered at 5.15 P.M. on Friday, May 15, at the Science Museum, South Kensington.

THE Carnegie Gold Medal of the Iron and Steel Institute has been awarded to Mr. E. Valenta, of the Skoda Works, Pilsen, for his work entitled "Heat and Acid-resisting Cast Iron with High Chromium and Carbon Content".

BY his will, the Hon. Sir Charles Algernon Parsons, who died on Feb. 12, aged seventy-six years, bequeathed £4000 to the North-East Coast Institution of Engineers and Shipbuilders; £3000 to the Armstrong College, Newcastle; £3000 to the Royal Institution of Great Britain; and £2000 to the British Association.

THE second Spiers' memorial lecture of the Faraday Society will be given by the president, Dr. Robert L. Mond, on June 17, at the Royal Institution. The lecture will be entitled "Michael Faraday", and tickets for admission may be obtained from the Secretary of the Faraday Society, 13 South Square, Gray's Inn, London, W.C.1.

THE Geological Society of London will hold a conversazione in the Society's apartments in Burlington House on June 3, from 8.30 to 11 P.M. During the evening, Dr. W. F. Whittard will describe the geological work of the Cambridge expedition to Greenland in 1929.

AT a dinner of the Society of Apothecaries on April 28, Sir Stanley Hewett, Surgeon-Apothecary to the King, was presented with the diploma of the Society (*honoris causa*). This is the third time only that the honorary diploma has been presented, the other two having been awarded to the Prince of Wales and Sir John Lynn-Thomas, consulting surgeon of King Edward VII. Hospital and to the Welsh National Memorial Association.

THE Council of the Institution of Civil Engineers has made the following awards in respect of papers read and discussed at the ordinary meetings during session 1930–31: A Telford Gold Medal to Mr. W. T. Halcrow (London); Telford Premiums to Mr. F. R. Freeman (London), Mr. G. C. Minnitt (Bombay); jointly to Mr. C. S. Berry, Mr. H. P. Gaze, and Mr. C. E. H. Verity (London); and jointly to Prof. A. H. Gibson (Manchester), Mr. T. H. Aspey, (Wigan), and Mr. F. Tattersall (London); a Manby Premium to Mr. A. R. Ellison (Nag Hammadi, Egypt); a Crampton Prize to Mr. R. T. McCallum (Derby); the Council would have awarded a Telford Premium to Mr. Percy Allan (Sydney, N.S.W.) had he been still living.

THE Dorothy Temple Cross Research Fellowships in tuberculosis for the academic year 1931–32, for persons "intending to devote themselves to the advancement by teaching or research of curative or preventive treatment of tuberculosis in all or any of its forms", will be awarded shortly by the Medical Research Council. Candidates must be British subjects and possess suitable medical, veterinary, or scientific qualifications. The fellowships will preferably be awarded to those who wish to conduct inquiries outside Great Britain. They are generally awarded for one year, and are of the value of not less than £300 per annum, with travelling expenses in addition. It may also be possible to award a Senior Fellowship of considerably greater value to a specially well qualified candidate wishing to undertake an intensive study of some particular problem of tuberculosis at a chosen centre of work outside Great Britain. Particulars and forms of application, to be returned before June 6, are obtainable from the Secretary, Medical Research Council, 38 Old Queen Street, Westminster, S.W.1.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A director of the Research Institute of the Cancer Hospital, Fulham Road—The Secretary, Cancer Hospital, Fulham Road, S.W.3 (May 11). An assistant master for mathematics and electrical engineering in the Junior Technical School for Boys of the Paddington Technical Institute, and for evening classes—The Education Officer (T.1), County Hall, S.E.1 (May 16). A technical assistant under the Department of Scientific and Industrial Research, for abstracting work in connexion with fuel research—The Secretary, Department of Scientific and Industrial Research, 16 Old Queen

Street, S.W.1 (May 18). A technical assistant in the department of economics of the Edinburgh and East of Scotland College of Agriculture—The Secretary, Edinburgh and East of Scotland College of Agriculture, 13 George Square, Edinburgh (May 18). An assistant tutor for adult education in rural districts, principally, in North Lancashire under the Lancashire Education Committee—The Director of Education, County Offices, Preston (May 20). An assistant lecturer in mathematics at Westfield College—The Principal, Westfield College, N.W.3 (May 27). A principal of Brierley Hill Technical Institute—The Director of Education, County Education Offices, Stafford (May 27). A student probationer (zoologist or physiologist) at the M.B.A. Laboratory, Plymouth—The Director, Marine Biological Laboratory, Plymouth (May 29). An assistant lecturer in the department of mathematics of the University College of Swansea—The Registrar, University College, Singleton Park, Swansea (May 30). A professor of pathology in the University of Hong Kong—The Chief Medical Officer, Ministry of Health, Whitehall, S.W.1 (June 24). A part-time lecturer in engineering production and works management at Battersea Polytechnic—The Principal, Battersea Polytechnic, S.W.11. A biology master at Haileybury College—The Master, Haileybury College, Hertford.

Our Astronomical Column.

The Siberian Meteor of June 30, 1908.—The *Scientific American* for April contains a note by J. G. Crowther on the above meteor, which is undoubtedly the most remarkable one on record. It will be remembered that many square miles of forest were levelled, thousands of reindeer killed, and that a blast of hot air was felt by people at a considerable distance from the fall. Mr. Crowther now reproduces barographs taken on that day at five stations in England; they all show a series of well-marked oscillations, at times that get later as they are farther from the place of the fall. The deduced velocity is about that of sound, and the time of travel from Siberia to England is 5 hr. 10 min., which is about right for a sound journey of 3550 miles. Hence there is little doubt that the oscillations indicate air-waves produced by the fall.

There is, however, a further phenomenon; that evening there was a remarkable, red sunset glow which lasted all night. At midnight it looked like the glare of a distant conflagration. A photograph of the Greenwich Naval College was taken from the Royal Observatory at midnight by the light of the glow. It was discussed at the meeting of the British Astronomical Association on July 1 (see *Jour. Brit. Astr. Assoc.*, **18**, No. 9, p. 354). Mr. H. P. Hollis said: "About half-past nine as seen from Greenwich, it did not differ much from a fine sunset, except that the luminosity was more to the north than sunset effects usually are, but the appearance lasted, and at one o'clock had shifted a little to the east, being if anything rather more brilliant than it had been earlier. But the most remarkable thing was the light over the whole of the northern sky, which was then as bright as the southern sky is when there is full Moon."

The writer of this note remembers that at the time he compared the phenomenon with those that followed the eruption of Krakatoa in 1883, and suggested that there might have been an eruption in some little known region. But it now appears that it was probably due to dust raised by the meteor, and carried westward by the same rapid current in the upper air that carried the Krakatoa dust so quickly round the world. The speed would be 185 miles per hour. Mr. Crowther records that at 7 P.M. on June 30, Mr. de Veer, of Haarlem, saw "an undulating mass to the north-west; it was not cloud, for the blue sky itself seemed to undulate".

The meteor may have belonged to the Pons-Winnecke swarm, but it could not (as is erroneously suggested in the article) have been the comet itself, as that passed perihelion on Oct. 9, 1909, so that it was a long way from the earth in June 1908.

Temperatures of the Sun, Moon, and Mars.—Prof. H. N. Russell gives in the *Scientific American* for April an account of recent researches at Mt. Wilson by Messrs. Pettit and Nicholson, using a delicate thermopile on the 100-inch reflector. They find for the moon's surface under a vertical sun the temperature 101° C., just above boiling water; at altitudes 60°, 30°, and 10° the temperatures are 88°, 40°, and −30° respectively. They studied the effect of an eclipse of the moon, finding that a region that was at 60° C. before the eclipse began, fell to −100° when the region entered the umbra; the return of heat after the eclipse was also rapid, suggesting that the moon's surface is composed of loose volcanic ash and that the heat only penetrates a few inches below the surface. The temperature at night is concluded to fall below −150° C. There is thus a range of 250° C. between day and night in the equatorial regions of the moon; this would tend to disintegrate rocks by alternate expansion and contraction, as R. A. Proctor pointed out fifty years ago. New observations on Mars indicate that with an overhead sun in perihelion the temperature is 18° C. The temperature at the pole at the end of summer is about the same. Observations of sunspots gave for their temperature 4750° K., or about 1200° cooler than the surrounding photosphere. This refers to the middle of the disc, where vision penetrates to a lower layer in the sun than with oblique rays.

Perturbations of Wolf's First Periodic Comet.—*Circular* No. 10 of Warsaw Observatory contains a summary of Prof. M. Kamienski's exhaustive researches on the motion of this comet from 1884 to 1919. The comet was observed at every return in this interval, except that of 1905. After the perturbations of all the planets except Mercury and Neptune have been carefully computed and applied, there are several fairly large residuals, amounting in seven cases to 14″ or more. It is shown that these can be greatly reduced by the assumption that the mean daily motion of the comet is diminishing by the amount 0·00000042″ per day; this is in addition to the changes due to planetary perturbations. There is now one residual of 6″, one of 5″, the remainder are less than 4″. The mean residual is reduced from 6·5″ to 1·8″. The author points out the similarity to the case of Encke's comet, found by Prof. O. A. Backlund to have an increasing mean daily motion. De Sitter's value of the mass of the system of Jupiter was used; it is 1/1047·40. Incidentally, the result supports de Sitter's conclusion that it is better not to use results based on comets in adopting the mass of Jupiter, since these are subject to unexplained anomalies.

Research Items.

Art of the Bush Negroes of Dutch Guiana.—For some years, Dr. Morton H. Kahn has conducted expeditions to Dutch Guiana on behalf of the American Museum of Natural History, with the object of investigating the culture of the descendants of the West African Negro slaves who revolted from the Dutch in the seventeenth century, and have remained practically untouched by white or Indian influence ever since. He has now contributed to the *Journal* of the Museum an advance account of their art in anticipation of a book on these people which he is about to publish. Their art is a well-developed highly conventionalised form with considerable social significance. Common objects of every-day life are developed by carving into highly elaborated forms. Combs, paddles, stools, and other objects show great beauty of form and design with a sense of line and balance. The carving is done by men, and the objects have a ceremonial significance, for these wooden pieces are tokens of love. Though the people are largely promiscuous, there is a certain amount of wooing necessary, which is done by means of the presentation of a carved object. A woman is, therefore, proud of her collection of carved objects and does not part with them readily, for each piece is the token of the affection of a male. As a skilful carver is held in considerable repute, and those who are not skilful must obtain their services by trading game or fish, wood-carving is practised assiduously from boyhood. The carved objects are made of hard jungle wood, some of lignum vitæ, those of light wood not being popular. The carving is done with a jack knife and a pair of compasses and finished with matted grass and river sand. The objects are not used for trade purposes. Colour other than that natural to the wood is not usually shown, though occasionally inlay of other woods is employed. The objects are sometimes so highly carved as to be useless. The symbolism of the designs is individual. Prominent motives are the snake, the vulva, and the human scapula.

Ecological Methods and the Tsetse Problem.—In *Ecology*, vol. 11 (1930), pp. 713-733, Dr. J. F. V. Phillips discusses the application of ecological methods to a better understanding of the behaviour of the tsetse fly (*Glossina* spp.) in Tanganyika Territory. At least 60 per cent of the country is either lightly or densely infested by various species of *Glossina*, the most important being *G. morsitans* and *G. swynnertoni*. In 1925 funds became available, through the Tsetse Subcommittee of the Committee of Civil Research, for the establishment of a special department for the scientific study of the vectors of trypanosomiasis and its organisation upon lines of modern ecology. The detailed application of the latter method, it may be added, is under the direction of Dr. Phillips. The conception of the plan of campaign is based upon the fact that tsetse flies are associated in varying degrees not only with the specific animals upon the blood of which they feed, but also with vegetation communities. The tsetse fly investigator requires, therefore, to be versed both in the purely entomological aspects of the problem, and also to have a knowledge of the relationships of the biotic communities whereof the insect is a constituent. It would appear that a productive method of helping to solve the menace of these insects lies in an understanding of its ecology. The principal lines of investigation include the detailed study of the insects in relation to the physical and biological characters of their environment; their interrelations with the vertebrate fauna; their biological control and the experimental alteration of the biotic and physical characters of selected areas. These and other aspects of this great problem are discussed in this paper which outlines a comprehensive and far-reaching plan of campaign.

Fauna of the Dutch East Indies.—The scientific results of the expedition of the Prince and Princess Leopold of Belgium accompanied by Prof. Van Straelen in 1929 (Résultats scientifiques du Voyage aux Indes Orientales Néerlandaises de LL. AA. RR. le Prince et la Princesse Léopold de Belgique, publiés par V. van Straelen, Directeur du Musée Royal d'Histoire Naturelle. *Mémoires* du Musée Royal d'Histoire Naturelle de Belgique) are being published handsomely in quarto form, eight parts of which have been issued in 1930. These cover a wide field, and each is written by an expert. Vol. 2 contains "Suesswasserschwaemme", fas. 2, by Walther Arndt; "Cœlentères hydropolypes", fas. 3, by E. Leloup; "Schyphomedusen", fas. 4, by G. Stiasny; and "Oligochæten", fas. 5, by W. Michaelsen: vol. 3 includes fas. 1, "Isopoda (excl. Oniscoidea and Epicaridea)" by A. F. Nierstrasz, and "Isopoda Epicaridea" by H. F. Nierstrasz and G. A. Brender a Brandis; fas. 2, "Parasitic Copepoda" by W. H. Leigh-Sharpe, and fas. 3, "Cirripedes" by C. A. Nilsson-Cantelli—vol. 5, fas. 1, containing "Batraciens" by S. F. de Witte. The most comprehensive are the parts on the oligochætes and the crustacea; fourteen species of cirripedes being recorded from various parts of the Malay Archipelago, including a new genus and two new species, two new species of parasitic copepods, and some interesting new isopods. The oligochætes collected belong mostly to the large genus *Pheretima*, and these are very carefully worked out. Most of the papers are illustrated by text figures, but there are line drawing plates in Leigh-Sharpe's "Parasitic Copepoda" and photographic plates in Leloup's "Hydroids", all of which are good.

Growth of Lobsters.—An appendix to the *Interim Report* (Report on Crabs, 1930) of the Interdepartmental Committee on Crabs and Lobsters (London: H.M. Stationery Office), by Mr. Richard Elmhirst, brings out some interesting facts with regard to the growth of lobsters. The growth curves from all available data show that a three-year-old lobster is about 110 mm. long. These data are from lobsters reared in captivity and also from those marked and recaptured. After about seven years the growth is slow. At about ten years old the males and females are of equal size, but nearly all very large lobsters are males. At first the females grow faster than the males, but when maturity sets in the growth is slower. Weighing experiments which have been undertaken at the Millport Laboratory, especially with reference to the increase of weight at moult, show that this increase may be as much as 30 per cent; but exceptional cases are cited and one lobster was actually lighter after the moult. The cast shell is eaten by the lobster, even if this is withheld for some time. There is no relation between the weight of exuviæ consumed and the increase of weight during the shell-eating period, the lime taken in during hardening probably replacing water in the skin. The data available show that the inter-moult increase is about 10 per cent in males and 8 per cent in females. Tables are given showing details both of lengths and weights.

***Parapseudecheneis*, a New Genus.**—Dr. Sunda Lal Hora and Dr. Paul Chabanaud have studied the siluroid fish *Pseudecheneis paviei* in much detail, and find that it is undoubtedly not congeneric with *Pseudecheneis sulcatus*, the only other species ascribed

to the genus. In their paper "The Siluroid Fish *Pseudecheneis* and an Allied New Genus" (*Records* of the Indian Museum, **32**, 3, Oct. 1930) they describe the characters of both genera. *Pseudecheneis* and *Parapseudecheneis* both have an adhesive apparatus composed of a series of transverse lamellæ resembling in superficial appearance and form the adhesive disc of *Echeneis* or *Remora*, but they are quite different in general form, especially in the head region. It is suggested that both genera are derived from those members of the genus *Glyptosternum* which live in calm and placid waters of the highlands of Central Asia. The fact that the pectoral fins are placed somewhat higher than the ventral surface of the body shows that they have taken to life in rapid waters comparatively recently, and that their ancestors were probably well adapted for life in deep and calm waters. *Pseudecheneis* and *Parapseudecheneis* appear to have been evolved from two different stocks, but, under the influence of the current, have developed a similar type of adhesive apparatus.

Larch Poles for Transmission Lines.—Experiments have been carried out at the Forest Products Research Laboratory at Princes Risborough in the treatment of home-grown larch poles to render them suitable for use in telegraph, telephone, and power transmission lines. The objections to larch (which for many purposes has long been held in high repute in Great Britain) for transmission lines are apparently based on the behaviour of creosoted poles used during the War. It was recorded of these poles that the creosote did not penetrate the pole to any depth when subjected to the methods of treatment then in use; consequently after erection the poles were liable to crack or split severely. Experiments carried out with consignments of poles from the well-known larch woods in Tintern Forest have shown that with suitable treatment these difficulties can be overcome. By peeling and making a number of incisions in the poles with a broad knife, a satisfactory penetration of the preservative is obtainable. Although the incisions have a slight weakening effect on their strength, home-grown larch poles so treated are said to be 25–30 per cent stronger than imported poles of Scots pine of the same dimensions. Provided, therefore, that the larch poles are grown as clean as the imported pine, they should easily be able to hold their own in competition. *Bulletin* No. 8 of the Forest Products Research Laboratory (Jan. 1931), recently issued by the Department of Scientific and Industrial Research, gives full technical details of the experiments carried out.

The Old English Mile.—In a paper recently published in the *Geographical Journal*, Sir Charles Close showed that the mile in use in the fourteenth century in England was not less than ten furlongs. Lieut.-Col. J. B. P. Karslake returns to this matter in the *Geographical Journal* for April, and shows that the old English mile was actually eleven furlongs. This can be proved to be the mile of 1500 paces. It was identical with the *leuga*, the common unit of maximum linear measurement in early Saxon times. It was introduced into England in the first century B.C., and it is the measurement that was used in the Domesday survey. Apparently it was replaced by the mile of eight furlongs by the use in Saxon times of the Roman mile of 1000 *passus*, divided into eight *stadia*. So early as the ninth century, the *stadium* became the equivalent of the furlong. This mile of eight furlongs was adopted by the Post Office on its establishment in the reign of James I. for the determination of rates of horse hire for postal purposes. Thus milestones eight furlongs apart were set up, and this mile became the accepted standard of measurement in Great Britain.

The Labrador Current.—In a report on the coastal waters of Labrador based on explorations in 1926 (*Proceedings* of the American Academy of Arts and Sciences, vol. 66, No. 1), Mr. C. Iselin directs attention to certain features of the Labrador current revealed by sections across its waters. Two sections showed that the colder water is separated from the coast by a band of fresher warm water derived from land drainage, and that the coldest water in the current lies at a depth of about one hundred metres. A further comparison with sections of the current taken some years ago in Davis Strait shows that the current keeps practically the same temperatures and salinities throughout. A cross section in Davis Strait gives 10 square miles of water below 0° C., and a cross section off Sandwich Bay in the south of Labrador gives a comparable figure of 12·45 miles. The temperature of the body of the current (− 1° to − 1·5° C.) is maintained by scanty solar warming, the shortness of the summer, and the melting of bergs and floes, which hinder any rise in temperature. Mr. Iselin points out how the water supply from the surface of Labrador supplies an urge for the current, just as he believes that the chief source of the current is the urge supplied in Baffin Bay by land drainage and the northward-setting West Greenland current. Low salinity, in spite of low temperature, gives a reduced salinity on the west of the bay. The eastern side has a higher salinity by the inflow of Atlantic water. This difference forces the western waters southward.

Magnetic Analysis of α-Rays.—An article by S. Rosenblum in the December number of the *Journal de Physique*, on recent progress in the study of the magnetic spectra of α-rays, contains some details of the apparatus by means of which he was able to show that certain α-rays, for a long time accepted as simple, actually consisted of discrete groups. The magnet employed was the large one of the Paris Academy of Sciences. The largest pair of pole-pieces used had a diameter of 75 cm., and gave a constant field of 24,000 gauss over a region 35 cm. in diameter, which was adequate to enable him to apply to α-particles the focusing method with large deviations that had already been used with much success with β-particles by Ellis, Meitner, and others. The paper contains several interesting photographs of apparatus, as well as a number of reproductions of the magnetic spectra of the α-rays from thorium C.

Past and Future in Quantum Mechanics.—In a short communication appearing in the second March issue of the *Physical Review*, Prof. A. Einstein, R. C. Tolman, and B. Podolsky have raised the question of whether or not the quantum mechanics limits knowledge of the past path of a particle in the same way that it does knowledge of its future. The test is made by consideration of an idealised experiment of a type now familiar in demonstrations of the uncertainty principle. The history of two particles proceeding from one region of space to another by different routes is followed out in detail; and, to avoid a paradox in connexion with measurement of time and energy, it is first shown that momentum cannot be determined without changing its value, and then the original problem is decided in the negative. A final remark is added to the effect that it is desirable to emphasise that quantum mechanics imposes limitations on the localisation in time of a macroscopic phenomenon like the opening and closing of a shutter.

Reduction of Potassium Per-rhenate.—Noddack, one of the discoverers of the new element rhenium, found that the yellow oxide, Re_2O_7, when heated in sulphur dioxide, was reduced to a blue oxide of indefinite composition, and this when heated in

hydrogen gave a black oxide ReO_2. This was not obtained with milder reducing agents on a per-rhenate solution, these yielding a yellow solution which when made alkaline with barium hydroxide gave a yellow precipitate believed to be barium rhenate. The yellow solution was believed by Noddack to be rhenic acid. In the March number of the *Journal of the Chemical Society*, Briscoe, Robinson, and Stoddart describe experiments which show that the first light-coloured product of reduction is a colloidal suspension of the black material which it afterwards yields. This black product is ReO_2, $2H_2O$, and can be obtained quantitatively from the per-rhenate, a reaction reminiscent of that by which the black reduction product of osmic acid, namely, OsO_2, $2H_2O$, is produced. No evidence of the formation of rhenic acid or the precipitation of barium rhenate was obtained. The action of various reducing agents under varying conditions is described in the paper. The hydrate ReO_2, $2H_2O$, when heated at 250° for twelve hours in an evacuated tube gave the anhydrous oxide, ReO_2, in the pure state.

Cosmic Rays.—M. F. Baldet contributes to *L'Astronomie* for March an interesting review of the progress of knowledge about these rays. So far back as 1903, Rutherford and McLennan had noticed the tendency of electroscopes to lose their charge; they thought that this might arise from gamma-rays of terrestrial origin. To test this, an electroscope was carried up to a great height by a free balloon in 1910; it was found that the loss of charge was more rapid than on the ground, suggesting that the rays had a cosmic origin. Prof. Millikan discovered in 1913 their remarkable penetrating power, finding that it needed 20·8 metres of water, or 1·8 of lead, to quench them. It was inferred that their wave-length was only 1/50 of that of the gamma-rays. It was shown that the rays did not come from the sun, since there was no appreciable difference between the strength by day and by night. When Prof. Størmer traced auroræ to the impact of electrons from the sun, it was thought that these rays might arise in a similar manner; accordingly Prof. Millikan made an expedition last year to Hudson's Bay, near the magnetic pole; there were bright auroræ on three nights, but the strength of the cosmic rays was no stronger than at Pasadena. It was concluded that they are not connected with the aurora. A slight tendency has been found for the strength of the rays to vary with the barometer; this is explained by atmospheric absorption, since the barometer measures the mass of air above the place. M. Baldet goes on to explain Prof. Millikan's suggestion that these rays may have their origin in the coming together of hydrogen atoms in space, to build up more complex atoms; such transformations would be accompanied by an emission of energy. Sir James Jeans prefers to explain them by the annihilation of protons and electrons, showing that this would give rays of the right wave-length.

The Antimony Electrode.—The electrode consisting of metallic antimony in a solution containing solid antimonous oxide (Sb, Sb_2O_3) has been used in electrometric titrations and can be applied in cases where the hydrogen and quinhydrone electrodes do not function satisfactorily. It has also been used to measure *p*H values. In the March number of the *Journal of the Chemical Society*, Britton and Robinson describe experiments made with the object of determining the scope of the electrode as a titrimetric indicator and the extent to which the electromotive forces may be accurately converted into *p*H values, previous researches on the latter not being in good agreement. The work dealt with acids (including hydrocyanic acid) and salts which could not be titrated in the presence of the hydrogen or quinhydrone electrode. The results show that the antimony electrode possesses a wide range of applicability and is capable of rapidly indicating prevailing *p*H values with a moderately high degree of accuracy. A single universal buffer solution was employed, composed (according to the work of Prideaux and Ward) of a mixture of phosphoric, phenylacetic, and boric acids, each 0·04 molar, neutralised with 0·2 normal sodium hydroxide. Rods of pure cast antimony, cleaned with emery paper at the beginning of each titration, and purified antimonous oxide added to the buffer solution, were used, but it was found that addition of the oxide was unnecessary. Vigorous mechanical stirring is essential.

Flame Temperatures.—Jones, Lewis, Friauf and Perrott in the March number of the *Journal of the American Chemical Society* record measurements of the temperatures of hydrocarbon flames made at the Pittsburgh station of the U.S. Bureau of Mines. The method used was the reversal of spectrum lines of sodium and lithium salts in the flame, a heated tungsten strip examined by an optical pyrometer providing the light transmitted through the flame. The flame temperature increases rapidly, starting with a mixture near the lower limit of inflammability, and reaches a maximum with a gas-air mixture containing combustible slightly in excess (due to dissociation of the products) of that requisite to consume all the oxygen present. With further increase in percentage of combustible the flame temperature falls again, although not so sharply as for mixtures containing excess oxygen. The maximum flame temperatures of the gases tested vary from 1880° for methane to 1975° for ethylene; the maximum variation for the different hydrocarbons is less than 100°. The maximum flame temperatures of the unsaturated hydrocarbons (ethylene, propylene, butylene) are higher than those of the saturated hydrocarbons (methane, ethane, propane, butane, isobutane). The combustible gas-air mixture which gives the highest flame temperature does not correspond to that which gives the highest speed of uniform propagation of flame, except for methane and possibly Pittsburgh natural gas. In other cases the mixtures for highest flame temperature contain less combustible gas. Attempts to calculate the flame temperatures, making use of specific heats, gave satisfactory results, the temperatures being 100° higher for the unsaturated and 40°–70° higher for the saturated hydrocarbons, in such a direction as to account for the difference by radiation losses from the flame.

Deformation of a Single Crystal of Silver.—A normal sample of silver consisting of an aggregate of crystals when worked and annealed is known to twin readily. This metal was, therefore, chosen by Gough and Cox (Institute of Metals, annual general meeting, Mar. 11) to investigate the formation of such twins in a single crystal. After being subjected to alternating torsional stress, however, no definite twin markings were to be observed, though the surface was covered by slip-bands on octahedral planes and in good agreement with the maximum shear-stress hypothesis of elastic failure. After complete fracture, the specimen was vacuum annealed without, however, any twins being produced. Under compressional stress, both static and dynamic, the same result was obtained. The complete failure to produce twins in these experiments must be held to constitute proof of an essential difference of the mode of deformation between the single crystal and an aggregate.

Climatological Literature and Research.

PROF. R. DeC. WARD'S recent paper, entitled "The Literature of Climatology",[1] deserves to be brought to the notice of English readers. It is an attempt, in so few as eighteen pages, at a survey of the various lines along which climatological research has been carried out, and of the literature available in each branch. There are a number of branches of science—for example, biology, medicine, and engineering—in which a research worker is sometimes confronted with the need for information about the climates of different parts of the world, and the precise kind of information required varies with the nature of the research work that is being done.

Prof. Ward tells us that the number of inquirers seeking the kind of information that his survey attempts to supply is greater among workers in subjects not obviously connected with climatology than among meteorologists and climatologists. Their special requirements are many. In agricultural science, soil temperature, the water content of soils, the extent to which the moisture present in the air as invisible vapour falls below the amount required to produce saturation, and the desiccating power of the air, may all be of particular interest. It is important for the inquirer to know whether any or all of these items have been studied, and, if so, where the necessary books of reference are to be found. The anthropologists, with their curiosity about past climates, must follow up a different branch of climatology with a literature of its own.

Prof. Ward is known on the eastern side of the Atlantic for his excellent work on American climates; he may become even better known if he will call in the aid of the official librarians of different countries, and produce the comprehensive survey of which his present paper might well form the nucleus. In an addendum to the paper, the author admits the consciousness that he has done his work with a certain degree of sketchiness—that is a feature of the paper that most meteorologists will undoubtedly notice. But until the thorough cataloguing of the available literature has been done in combination with a judicious weeding out of the unreliable or unsuitable works, few are likely to judge of the extent to which this fault is present.

A recent paper by Dr. C. Braak [2] is an example of meteorological literature of importance outside climatology. The requirements of horticulture have no doubt influenced the course of meteorological study in Holland, and most of the information given in Dr. Braak's paper is of practical importance to nurserymen, who are very much concerned with minimising frost damage, and must take advantage of any available knowledge about the average annual march of temperature both in the air and in the ground, and of the abnormalities of this seasonal march that may be expected to occur in particular years. Dr. Braak's paper is supplementary to an earlier paper by Ch. M. A. Hartman, No. 24 of the same series of publications, in which air temperature alone was considered. Dr. Braak deals, however, with earth as well as air temperature.

In regard to air temperature, the author's discussion is on the customary lines. He does not omit to give statistics in regard to the earliest and latest dates of frost. There is little that calls for criticism in these studies, unless one may be allowed to cavil at a minor point of interpretation of certain statistics in relation to the amount of water vapour in the atmosphere and to the occurrence of night frosts. Dr. Braak found that the average vapour pressure on nights of frost at each of thirteen representative stations was greatest for stations nearest to the coast, and diminished on passing inland. For example, the mean value was 5·6 millibars at Winterswijk and 7·1 millibars at Katwijk, the first named being an inland station, and the last named a coastal one. This is cited as evidence that the distribution of water vapour is of importance in determining the distribution of frost frequency.

Now it is well established that dryness of the atmosphere up to a considerable height favours a rapid fall of temperature at night under a clear sky, but it seems doubtful whether these statistics can be said to prove it. If the interior had sharper frosts than the coast for some other reason, would not the greater fall of temperature ensure a lower vapour pressure as measured near the ground through the greater condensation of hoar frost or fog? It must be remembered that on still and initially clear nights temperature generally falls below the value corresponding with the dew-point at sunset, and condensation of some kind invariably takes place, provided that the sky remains clear and the wind light. The condensed moisture is partly derived from the air, and the water vapour is thereby reduced.

The section dealing with earth temperature gives far more information on this subject than is to be found in most text-books of meteorology. Using the equation

$$a_p = a\, e^{-p\sqrt{\frac{\pi}{kT}}}$$

where a_p is the amplitude of the periodic variation of period T at a depth p in the ground, and k is the thermal diffusivity given in terms of the depth of soil which can be warmed 1° C. by the heat passing in unit time (here 1 minute) through a layer of soil 1 cm. deep across which a constant difference of 1° C. is maintained, the thermal diffusivity of different soils at De Bilt, Wageningen, and Groningen are examined. The results are compared with similar information given for soils of the same type in Hann's well-known "Lehrbuch". The agreement is not close, but the Dutch observations are reasonably consistent among themselves, and the above-mentioned divergences may safely be referred to probable differences between the soils in the two sets of observations. The well-known effect of æration of the soil is brought out clearly: for a mixture of sand and peat, k was found to be 0·086 cm. at Groningen, and at the same place for a relatively compact and air-free mixture of clay and sand, k was 0·482. For peat and sandy clay, Hann gives 0·133 and 0·816 respectively. It is generally recognised that the conductivity of a particular soil is greatly affected not only by the amount of air contained in it but also by its water-content and by other factors, which provide additional sources of divergence when closely similar soils are compared at different times.

In conclusion, attention may be directed to interesting curves of air and soil temperature in the severe frosts of January–February 1917 and February 1929, on page 55. It is notable how, when the soil is frozen to some depth, the action of the latent heat of fusion of ice during a thaw destroys the normally good general agreement between curves of air temperature and soil temperature at a depth of less than 1 foot, and ex cellent examples are to be found in these curves. The same applies when freezing is taking place.

[1] *Annals* of the Association of American Geographers, March 1931.

[2] Koninklijk Nederlandsch Meteorologisch Instituut. No. 102, Mededeelingen en Verhandelingen, 33; Het Klimaat van Nederland. B (vervolg): Lucht- en grondtemperatuur. Door Dr. C. Braak. Pp. 78. (Amsterdam: Seyffardt's Boekhandel, 1930.) 1.00 f.

The National Institute of Industrial Psychology.

THE tenth annual Report of the National Institute of Industrial Psychology, as we have already indicated (May 2, p. 679), shows steady development of the work of the Institute, despite the prevalent industrial depression. Among the industrial investigations undertaken by the Institute in 1930 were time studies of the various operations of machine moulding in aluminium works, which have led not only to considerable savings in time but also to improvements in the working conditions, particularly in ventilation. Similar results have attended investigations in a calico dyeing and printing works; whilst studies of packing in a chocolate works led to the design of a new bench which increased output by 10 per cent, and also to the introduction of an improved packing method. Other problems examined relate to internal transport in a cotton doubling mill, and the Institute's investigations have been responsible for improvements in the organisation of such varied types of factories as gas works, engineering works, a potted meat and fish paste factory, radio works, rubber products factory, spinning mill, wireless and cable offices, oil distribution company. During the year, investigations conducted for the railways resulted in valuable recommendations for eliminating accidents in goods shunting and for reducing pilfering and damage to goods.

A feature of the industrial investigations of the Institute during 1930 is, however, the extent to which it has been called upon to apply its experience and methods of vocational selection to the solution of problems concerning personnel. Contributions of this kind have been made in the recruitment of staff for chemical works, cleaning works, the selection of telephone operators for the G.P.O., as well as in the selection of general staff for insurance offices and retail stores. It is thus evident that the value of the research in the field of vocational guidance already carried out by the Institute is now widely recognised, and the account of the Institute's Carnegie experiment, to be published under the title of "Methods of Choosing a Career", should be assured of a wide reading.

Research work is being carried out in this field in association with the Juvenile Employment Department of the Birmingham Education Committee to determine the applicability of the Institute's methods in the Borstal institutions. The Fife Carnegie experiment in vocational guidance has continued in co-operation with the Medical Department of the Fife Education Authority and with the Juvenile Advisory Committee of the Employment Exchange; whilst other members of the research staff are attempting to follow up private vocational guidance cases and to prepare occupational analyses for the use of the vocational guidance section. Some of the research on industrial psychology in progress at the Universities of Cambridge, London, Leeds, Durham (Armstrong College), Edinburgh, Glasgow, Aberdeen, and St. Andrews is itself definitely related to vocational guidance or selection. Examples are the studies of vocational guidance in the Cambridge area carried out by Mrs. Ramsay; of employment psychology at Durham, educational psychology at Leeds; on perseverance and character at King's College, London, and on the testing of printers' apprentices at Edinburgh.

The Institute of Industrial Psychology is itself responsible for research on the nature and measurement of the mental abilities involved in various types of factory assembly operations, on colour discrimination, on daily fluctuations in industrial efficiency, and on occupational prospects for boys, based on a representative group of 500 working boys, employed and unemployed. An investigation conducted by Dr. Pinard elaborated tests for perseveration which have facilitated a division of people into three and not into two classes as required by Jung's theory, and are now being applied for the selection of good leaders. A research on methods of diagnosing social ability, especially the capacity to 'handle' people, has been commenced, and investigations which have led to the elaboration of standardised tests for motor drivers have attracted a considerable amount of interest.

Not the least important feature of the Institute's work is that which it has carried out on behalf of the National Institute for the Blind (more particularly during the past year), its studies of the organisation, working methods, and conditions of various blind workshops. The interest of this work lies not so much in its remarkable effect in increasing efficiency in such workshops, but in the extent to which it assists the blind to become useful and effective members of the community and breaks down the isolation so characteristic of the blind worker.

The Microscope and the Paint Industry.

THE value of the microscope in the study of pigments is being increasingly realised by the British paint industry, also in Germany and elsewhere. It has long been known that chemical analysis alone was quite insufficient for evaluating the true properties of a pigment, but that particle size and shape are, among other things, of very great importance, especially in determining the nature and extent of the reaction, for example, between the pigment and an oil medium like linseed oil.

In a recent article in the *Farben Zeitung* (Mar. 7, 1931), Dr. A. V. Blom describes the results of an examination of red lead by a polariscope with crossed nicols. One of his principal findings was that the reactivity of the red lead with linseed oil depended not only on the size of the particles but also on their shape, and that even particles of the same form varied in this respect. He distinguished at least six different forms and conditions of particle, of which the first is smooth and crystalline, and not readily affected by linseed oil; the second is small and spherical, and the others are more or less oxidised varieties of the first or second. The most recent research in crystal growth has shown that atoms are most active at their edges and corners; also that crystals are made up of blocks or sections separated from one another by submicroscopic channels. Surface energy is not, therefore, uniformly distributed in a crystal, but varies with its molecular density, and the critical energy increment of the surface reaction may vary considerably in one and the same crystal. In the case of red lead, linseed oil only enters into reaction where it is in direct contact with the lead oxide surface, forming lead soap or linoleate. These soap molecules also occur in many different forms, including the colloidal, in which case they would not be seen between crossed nicols.

It was found that a 100 per cent red lead from which all free lead oxide had been removed by careful and repeated extraction with ammonium acetate solution was changed quantitatively in the course of two years into non-isotropic spherical crystals if it was in contact with pure linoleic acid. In commercial red leads, all these various forms of particles are found in widely differing proportions, causing correspondingly wide differences in the qualities of the red lead.

University and Educational Intelligence.

CAMBRIDGE.—The General Board has appointed Dr. H. Jeffreys, of St. John's College, reader in geophysics.

The Council of the Senate has recommended that it be authorised to inform the Plummer Trustees that the University would approve of the establishment in the University, on the John Humphrey Plummer Foundation, of professorships of inorganic chemistry, of mathematical physics, and of colloid science, and of an annual payment at the initial rate of £300 from the Plummer Fund towards the maintenance of the Department of Colloid Science.

The Council of the Senate has issued a report on the proposed allocation of the Rockefeller benefaction. In 1928, the International Education Board offered to provide a sum not exceeding £700,000, provided that the University obtained from other sources the balance of £479,000 necessary to put the scheme into operation. At his installation last year, the Chancellor announced that the University had received promises which would enable it to satisfy this condition. The complete scheme consists of two parts, one dealing with the University Library involving a capital sum of £500,000, and the other dealing with scientific developments involving a capital sum of £679,000.

On the scientific side of the Rockefeller scheme, money is to be received from the International Education Board *pro rata* as it has been collected and paid in from outside sources or guaranteed by the University. At present, the University has received approximately £110,000 from outside sources and £210,000 from the International Education Board. The income of the sums already in hand will be about £15,000. In the opinion of the Council of the Senate, this income is sufficient to finance those parts of the Rockefeller scheme which the heads of departments think can now suitably be put in hand, provided that the professorship of mathematical physics and a professorship of colloid science (to replace the temporary professorship of colloidal physics) are financed from the Plummer Foundation. The Council has accordingly recommended that the General Board be requested to take the necessary steps to bring into operation, by Oct. 1, 1931, so much of the scheme as can be carried out under present conditions.

EDINBURGH.—The University Court, at its meeting on April 27, resolved to appoint as the first professor of geography, Mr. Alan G. Ogilvie, at present reader in geography at the University, the appointment to begin from Oct. 1, 1931. The foundation of this new chair has been made possible by a grant from the Carnegie Trustees and funds collected by public subscription through the action of the Royal Scottish Geographical Society.

LONDON.—Prof. Max Jakob is giving a course of four lectures on "Steam Research in Europe and in America", at the Institution of Civil Engineers, on May 7, 8, 14, and 15 at 5.30 P.M. The lecture on May 14 will deal with optical measurements—theories and thermodynamical evaluation and control of the results of experimental work; and that on May 15 with special thermal properties and processes of water and steam, and a note on international steam table conferences and international steam tables. Admission to these lectures is free, without ticket.

OXFORD.—The debate on the enlargement and improvement of library facilities in Oxford has been postponed to May 19; the voting on the actual decree to take place on May 26. In each of the schemes now before Congregation, the addition is advocated of a new wing to the Radcliffe Science Library.

The Rhodes Memorial lectures will be delivered in German, on May 9, 16, and 23, by Prof. A. Einstein, on "The Theory of Relativity".

APPLICATIONS for a Ramsay Memorial Fellowship for Chemical Research will be considered at the end of June next. The fellowship will be of the annual value of £250, with a possible additional sum of not more than £50 per annum for expenses. The tenure of the fellowship will be two years, but it may be extended for a third year. Applications should be sent not later than June 5 to the Secretary, Ramsay Memorial Fellowships Trust, University College, Gower Street, W.C.1.

UNIVERSITY COLLEGE, London, in its recently published report for the year ending February 1931, records the closing, as from July 31, 1930, of the College Centenary Appeal Fund, which was inaugurated in 1925. The appeal was for £500,000 and towards this a sum of £227,764 was raised. Among the departments for the development of which contributions from the fund have been made are those of chemical engineering and zoology. To the former has been allocated more than £60,000, the full amount appealed for in 1925; but meanwhile the position and needs of the department have been reviewed by a special committee over which the late Lord Melchett presided and a further sum of £110,000 will be needed to give effect to this committee's scheme. For the department of zoology, the appeal asked for £50,000, but the International Education Board interested itself in the matter and offered to pay half the cost of a wider scheme involving an expenditure of £240,000. The question of ways and means for qualifying for this gift is now engaging the attention of the College Committee. The total number of students registered last session is 3150, as against 3249 the preceding year. The decrease is more than accounted for by the fact that there was in 1929 no vacation course in spoken English for foreign students, the attendance at which normally exceeds two hundred.

Birthdays and Research Centres.

May 9.—Sir JAMES IRVINE, F.R.S., Principal and Vice-Chancellor of the University of St. Andrews.

In large measure through the adoption of methods developed in my earlier researches on sugars, the structural chemistry of carbohydrates has been greatly expanded during the past thirty years. The progress is gratifying, yet, after all, it must be admitted that these advances, which enable us to ascribe structural formulæ to representative carbohydrates, do not lead very far towards the interpretation of fundamental problems.

So many questions remain unanswered: Is glucose the first product of photosynthesis? Why are sugars optically active, and why is the glucose configuration favoured above all others? By what processes are the hexoses converted one into the other? What is sucrose and how is it formed? These are but examples. If I had my scientific life to live over again, I would study these additional problems, but would do so under conditions approximating to those which prevail in plant and animal life. If it be the case that "even a paramecium is not quite himself under the fierce light which beats on the microscope stage", it is equally true that a sugar is unlikely to reveal its true characteristics when exposed to the fierce reagents of the organic chemist.

Societies and Academies.

LONDON.

Royal Society, April 30.—**A. E. H. Tutton**: Determination of the yard in wave-lengths of light. The author has carried out a determination of the number of wave-lengths of the red light radiations of hydrogen (H_α) and cadmium (Cd_r), and of the yellow radiations of neon (Ne_c), in the British Imperial Standard Yard, by an original method. The Imperial Standard Yard, at the official temperature 62° Fahrenheit and 760 mm. barometric pressure, is found to comprise 1,420,210·3 wave-lengths of the standard red lines of cadmium, Cd_r, 1,562,408·6 wave-lengths of the yellow neon line Ne_c, and 1,393,266·5 wave-lengths of the red hydrogen line H_α. Instead of relying on direct determinations with cadmium light, to produce which the vacuum tube has to be heated to 340° C., which was found gravely to affect the thermal equilibrium and thereby the accuracy of the observations, the direct determinations with H_α (which is very close to Cd_r) and Ne_c were used to calculate the value for Cd_r; the two independent values thus obtained for Cd_r were 1,420,210·8 and 1,420,209·8, an agreement which gives every confidence that the round number 1,420,210 is very near the truth. It is suggested that this round number might be taken as the length of the British yard.—**U. R. Evans, L. C. Bannister, and S. C. Britton**: The velocity of corrosion from the electrochemical standpoint. By excluding oxygen from the anodic areas, it has been found possible to tap and measure the whole of the electric current responsible for the corrosion of iron, and to show that the whole attack is of an electrochemical character. The current can never exceed that limiting value which would cause so much polarisation as to make the cathodic and anodic potentials equal; such 'equipotential' conditions are closely approached at high salt concentrations. Most of the polarisation occurs at the cathodic area. The law governing the ratio of anodic and cathodic areas is that the anodic area extends until the cathodic current density reaches the 'protective value' requisite to prevent further extension.—**T. L. Eckersley**: On the connexion between the ray theory of electric waves and dynamics. There is a very close analogy between the analytical description of the transmission of such electromagnetic waves and Schrödinger's wave theory of quantum dynamics. Optical ray methods are often used in the analysis of wireless wave transmission and the rays can be given a dynamical interpretation as the orbits of a group of waves (considered as a particle). The approximate ray method of analysis bears the same relationship to the true wave method that the Newtonian dynamics bears to the new wave mechanics. The theory can be applied to the transmission of waves between the earth and Heaviside layer, and approximate solutions obtained which, in the particular case of a well-defined conducting layer, give G. N. Watson's value of the attenuation coefficient. The solutions, like the older Bohr-Sommerfeld quantum solution, are incomplete, giving the direction cosines and attenuation coefficients, but not the amplitudes. The method, however, can be applied to a wide variety of cases.—**Lord Rayleigh**: On a night sky of exceptional brightness, and on the distinction between the polar aurora and the night sky. An exceptionally bright night sky on Nov. 8, 1929, is described, with photometric observations. It was of about four times the ordinary brightness and eight times the minimum ever observed. It was of the same chromatic constitution as usual, and the aurora line was not conspicuous. There was no accompanying magnetic disturbance. Spectra of the aurora and of the normal night sky are reproduced for comparison. Nitrogen bands are absent in the latter. Two unidentified bright lines in the night sky spectrum are remeasured. The wave-lengths found are 4419 and 4168.—**T. H. Havelock**: The wave resistance of a spheroid. It is shown how to calculate the wave resistance of an ellipsoid submerged in water and moving horizontally in any orientation. Explicit results are given for prolate and oblate spheroids moving in the direction of the axis of symmetry and at right angles to that axis.—**O. W. Richardson and P. M. Davidson**: The spectrum of H_2. The bands ending in $2p\ ^3\Pi$ levels. The bands of the H_2 spectrum are described which start on the levels $3d\ ^3\Sigma$, $3d\ ^3\Pi_{ab}$, $3d\ ^3\Delta_{ab}$, $4d\ ^3\Sigma$, $4d\ ^3\Pi_{ab}$, $4d\ ^3\Delta_{ba}$ and end in $2p\ ^3\Pi_{ab}$. The upper levels show pronounced uncoupling phenomena, and their properties are otherwise similar to those of the corresponding singlet levels of H_2 and also to those of the $d\ ^3\Sigma$, $d\ ^3\Pi$, and $d\ ^3\Delta$ levels of He_2. The $3d\ ^3\Sigma \rightarrow 2p\ ^3\Pi$ bands show a strong Zeeman response, just as do the $3d\ ^1\Sigma \rightarrow 2pi\ ^1\Sigma$ bands. The constants of the final II levels, common to all the bands, are in good agreement with the supposition that this is the continuation at $n = 2$ of the upper levels of the a, p, λ bands for which $n = 3$, 4, and 5.—**C. M. M'Dowell and F. L. Usher**. Viscosity and rigidity in suspensions of fine particles (1, 2). In lyophobic suspensions of charged particles in an aqueous liquid, variation of viscosity with rate of shear is dependent on the formation of aggregates, whilst rigidity depends on the linking of the aggregates to form a continuous structure. Measurements of rigidity and of viscosity in relation to rate of shear were also made in suspensions of uncharged particles in inert organic liquids of the same density as the solid, in conjunction with microscopic observations. Photomicrographs show the existence of aggregates and structures or their absence, accordingly as the suspensions exhibit or fail to exhibit variable viscosity and rigidity.

(To be continued.)

PARIS.

Academy of Sciences, Mar. 23.—**Elie and Henri Cartan**: The transformations of closed domains enclosing the origin.—**Paul Vuillemin**: The mode of action of malaria therapy. A discussion of the use of organisms causing fever in the treatment of syphilis and its sequels.—**J. Favard**: The zeros of polynomials.—**V. Romanovsky**: Generalisations of a theorem of E. Slutsky.—**G. Vranceanu**: Some theorems relative to non-polynomial varieties and systems of forms of Pfaff.—**Chevalley and Herbrand**: Topological groups, Fuchsian forms, free groups.—**Otton Nikodym**: Suites of perfectly additive functions of abstract ensembles.—**Tesar**: The representation, in magnitude and in direction, of internal forces in the case of problems of plane elasticity.—**P. Dupin and E. Crausse**: The vibration of cylindrical tubes in water under the influence of alternating vortices.—**L. Goldstein**: The quantic mechanics of collisions of the second kind.—**G. Dupouy**: Electrical measuring apparatus with moving coil in a uniform field. The usual construction makes the deviations of the coil proportional to the current to be measured. In certain cases, however, it is advantageous to design the magnetic field in such a manner as to increase the sensitivity at one point; the graduations are unequal, but over a certain portion of the scale the readings are very open. Such an arrangement is useful for relays. Other possible applications are suggested.—**J. Fridrichson**: The resonance spectrum of sulphur vapour.—**J. Barbaudy, A. Guérillot, and R. Simon**: A continuous recorder for the pH of nickel-plating baths. An application of the Leeds and Northrup recording potentiometer.—**René Dubrisay and R. François**: The solubility of

calcium carbonate in water in the presence of alkaline chlorides. The alkalinity of water in contact with calcium carbonate is increased by the addition of potassium chloride to the aqueous solution, and the alkalinity produced increases with the concentration of the potassium chloride. With the higher alkalinity increasing amounts of calcium pass into solution.—**P. Laffitte and M. Patry**: The velocity of the phenomena caused by the detonation of solid explosives.—**E. Carrière and Raulet**: Contribution to the study of the sodium silver hyposulphite complexes. Three compounds have been isolated and analysed, $NaAgS_2O_3$, $Na_4Ag_2(S_2O_3)_3$, and $Na_3Ag(S_2O_3)_2$, of which the first two have been previously described.—**F. Salmon-Legagneur**: α-Carboxycamphocean-β-acrylic and -β-propionic acids.—**F. Zambonini and V. Caglioti**: New researches on the chemical composition of romanechite.—**Mlle. Eliane Basse**: The structure of the massif of Mikoboka and of the plateau of Analavelona, south-west of Madagascar.—**Raymond Ciry**: The presence of a facies with cephalopods in the Coniacian of the north-east of the province of Burgos (Spain).—**Jean Marçais**: Observations on the geology of the region of Tizi Ouzli (Eastern Rif).—**Mihaïlovitch Jelenko**: The great seismic catastrophe of Mar. 8, 1931, in southern Jugo-Slavia.—**A. Eichhorn and R. Franquet**: The somatic karyokinesis of *Bolbostemma paniculatum*.—**Maurice Hocquette and L. Arsigny**: Secretion by the stem meristem of *Cuscuta epithymum* of substances injurious for the tissues of the hosts.—**Alb. J. J. Van de Velde, A. Verbelen, and L. Dekoker**: Biochemical researches on arable soil.—**Acolat**: Anatomical researches relating to the separation of venous blood and arterial blood in the frog's heart.—**Charles Pérez**: The roots of the parasitic rhizocephalic parasites of the hermit crab.—**Radu Codreanu**: The evolution of the *Endoblastidium*, a new genus of cœlomic parasite of the larvæ of *Ephemera*.—**G. Delamare and C. Gatti**: The spirochætes of an encysted pleurisy, offensive and temporarily gangrenous.

CRACOW.

Polish Academy of Science and Letters, Dec. 1.—Cz. Bialobrzeski: Four ways of looking at the mechanism of the radiation of a star. To the three modes of considering the radiation of a star mentioned in previous communications the author adds a fourth. The movement of the photons of which the radiation is composed can be treated like the Brownian motion. The mean time necessary for the photon to travel a distance equal to the radius of the star is calculated and the radiation of two stars is compared by means of the formulæ obtained.—**St. Mrozowski**: The hyperfine structure of the 2537 A. resonance line of mercury.—**Mlle. Z. Debinska**: The crystalline structure of cathode deposits. Gold and platinum deposited at temperatures of − 80° C. to − 180° C. show no crystalline structure: at definite higher temperatures a crystalline structure develops.—**K. Dziewonski and J. Schnayder**: Studies in the fluorene series (2). Syntheses of ketones: 2-acetofluorene and 2, 7-diacetofluorene.—**S. Maziarski**: The muscular tissue of insects (3). The periovarian muscular networks (myosyndesmium) in the Coleoptera.—**K. Sembrat**: Cytological researches on the plasma components and, in particular, on the Golgi apparatus and the vacuome during the gametogenesis of the Triclades, *Dendrocœlum lacteum* and *Planaria gonocephala*.—**F. Bieda**: The Nummulina fauna found in the pebbles of the conglomerates of the Polish Carpathians.—**J. Jodlowski**: The histological structure of the fibre glands of the larvæ of ants.—**R. J. Wojtusiak**: New observations on the faculty possessed by the larvæ of *Pieris brassicæ* of finding their way about.

Official Publications Received.

BRITISH.

The Science Masters' Association. Report for 1930 with List of Members (correct to February 1931), Statements of Accounts and Report of Business Meeting. Pp. 80. (Harrow: Harrow School Book Shop.)

Proceedings of the Royal Society. Series A, Vol. 131, No. A816, April 2. Pp. 274. (London: Harrison and Sons, Ltd.) 14*s*.

Quarterly Journal of the Royal Meteorological Society. Vol. 57, No. 239, April. Pp. 117-242. (London: Edward Stanford, Ltd.) 7*s*. 6*d*.

The Institution of Professional Civil Servants. Annual Report of Council for the Year 1930. Pp. xiii+58. (London.)

The Journal of the Institution of Electrical Engineers. Edited by P. F. Rowell. Vol. 69, No. 412, April. Pp. 445-556+xxx. (London: E. and F. N. Spon, Ltd.) 10*s*. 6*d*.

Education for the Engineering Industry. 1: Report of the Committee on Education for the Engineering Industry; 2: Comments on the Report by Educational Bodies. Pp. vii+67. (London: H.M. Stationery Office.) 1*s*. 3*d*. net.

Proceedings of the Society for Psychical Research. Part 118, Vol. 39, April. Pp. 375-418. (London.) 5*s*.

Reports of the Great Barrier Reef Committee. Vol. 3. Pp. v+72+10 plates. (Brisbane: Frederick Phillips.)

The Marine Biological Station at Port Erin: being the Forty-fourth Annual Report of the former Liverpool Marine Biology Committee, now the Oceanography Department of the University of Liverpool. Drawn up by Prof. Jas. Johnstone. Pp. 36. (Liverpool: University Press of Liverpool.) 1*s*. 6*d*. net.

FOREIGN.

U.S. Department of Agriculture. Technical Bulletin 221: Wild-Duck Foods of North Dakota Lakes. By Franklin P. Metcalf. Pp. 72. (Washington, D.C.: Government Printing Office.) 15 cents.

University of Illinois Engineering Experiment Station. Bulletin No. 221: An Investigation of Core Oils. By Carl H. Casberg and Carl E. Schubert. Pp. 19. 15 cents. Bulletin No. 222: Flow of Liquids in Pipes of Circular and Annular Cross-Sections. By Prof. Alonzo P. Kratz, Prof. Horace J. Macintire and Richard E. Gould. Pp. 26. 15 cents. Bulletin No. 223: Investigation of various Factors affecting the Heating of Rooms with direct Steam Radiators. Conducted by the Engineering Experiment Station, University of Illinois, in coöperation with the Institute of Boiler and Radiator Manufacturers and the Illinois Master Plumbers' Association. By Prof. Arthur C. Willard, Prof. Alonzo P. Kratz, Maurice K. Fahnestock and Seichi Konzo. Pp. 102. 55 cents. Bulletin No. 224: The Effect of Smelter Atmospheres on the Quality of Enamels for Sheet Steels. A Report of an Investigation conducted by the Engineering Experiment Station, University of Illinois, in coöperation with the Utilities Research Commission. By Prof. Andrew I. Andrews and Emanuel A. Hertzell. Pp. 15. 10 cents. Bulletin No. 225: The Microstructure of some Porcelain Glazes. By Clyde L. Thompson. Pp. 21. 15 cents. (Urbana, Ill.)

CATALOGUE.

Zenith Resistances and Rheostats. Pp. 35+15. (London: The Zenith Electric Co., Ltd.)

Diary of Societies.

FRIDAY, MAY 8.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (at Town Hall, Morecambe), at 11 A.M.—P. W. Ladmore: Recent Municipal Works in Morecambe and Heysham.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Prof. W. de Sitter: Jupiter's Satellites (George Darwin Lecture).

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Human Monsters and Malformations (3): Tumour-like Formations which appear to represent the Inclusion of one Twin within the Body of Another.

ROYAL SOCIETY OF MEDICINE (Clinical Section), at 5.30.—Annual General Meeting.

BRITISH PSYCHOLOGICAL SOCIETY (Æsthetics Section) (at Bedford College), at 5.30.—Prof. D. Tovey: Paper, with Musical Illustrations.

MALACOLOGICAL SOCIETY OF LONDON (at Linnean Society), at 6.—Dr. S. Stillman Berry: A Re-description of *Lepidozona clathrata* (Reeve).—C. Diver: A Method of Determining the Number of the Whorls of a Shell and its Application to *Cepœa*.—J. H. Fraser: On the Size of *Urosalpinx cinerea* (Say) with some Observations on Weight-Length Relationship.—Exhibit: British *Vertigo* and *Urosalpinx* and *Ocenebra*.

INSTITUTION OF ELECTRICAL ENGINEERS (London Students' Section), at 6.15.—M. G. Holmes and L. F. Salter: The Development of the London Automatic Telephone System.

RAILWAY CLUB (at 57 Fetter Lane), at 7.30.—C. R. G. Stuart: Great Southern Railways, Ireland.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Dr. G. W. C. Kaye: The Measurement of Noise.

INSTITUTION OF ELECTRICAL ENGINEERS (Scottish Centre) (at Forrester's Hall, Dundee).—Prof. W. Cramp: The Birth of Electrical Engineering (Faraday Lecture).

INSTITUTION OF STRUCTURAL ENGINEERS (at South Wales Institute of Engineers, Cardiff) (Annual General Meeting).—F. E. Drury: The Structural Engineer and his Vocational Training.

MONDAY, MAY 11.

ROYAL SOCIETY OF ARTS (Dominions and Colonies Section), at 4.30.—Major W. Elliot: The Work of the Empire Marketing Board.

ROYAL GEOGRAPHICAL SOCIETY, at 5.—Dr. S. W. Wooldridge and D. J.

Smetham: The Glacial Drifts of Essex and Hertfordshire and their Bearing upon the Agricultural and Historical Geography of the Region.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Human Monsters and Malformations (4): Parasitic Fœtuses of Various Kinds. Their Origin and Nature.

IRON AND STEEL INSTITUTE (at Cleveland Technical Institute, Middlesbrough), at 7.30.—O. Cromberg: Production Economy in Iron and Steel Works.—A. Robinson: The Melting Shop of the Appleby Iron Company, Limited.

CHARTERED SURVEYORS' INSTITUTION, at 8.—S. A. Smith: Valuations of the Assets of Public Companies.

MEDICAL SOCIETY OF LONDON.—Sir John Rose Bradford, Bart.: Annual Oration.

TUESDAY, MAY 12.

NATIONAL INSTITUTE OF INDUSTRIAL PSYCHOLOGY (at Royal Automobile Club), at 5.30.—Dr. G. H. Miles: Practical Tests for Drivers (Lecture in Connexion with National Safety Week).

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—Prof. Syuti T. Issiki: On the Morphology and Systematics of Micropterygidæ (Lepidoptera Homoneura) of Japan and Formosa, with Considerations on the Australian, European, and North American Forms.—W. Fernando: The Development of the Kidney in *Ampullaria* (*Pila*) *gigas* (Gastropoda).—E. Banks: The Forms of Prevost's Squirrel found in Sarawak.—Dr. R. Broom: (*a*) On the Skull of the Primitive Reptile *Ærœoscelis*; (*b*) On the Vomerine Bones in Birds.

INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.30.

INSTITUTION OF CIVIL ENGINEERS, at 6.—Annual General Meeting.

INSTITUTE OF MARINE ENGINEERS, at 6.—O. E. Jorgensen: Low Cost Motorships.

QUEKETT MICROSCOPICAL CLUB (at Medical Society of London), at 7.30.—A. E. Clarence Smith: Some Observations on Diatom Resolution and Structure.

ROYAL SOCIETY OF MEDICINE (Psychiatry Section), at 8.30.—Annual General Meeting.

WEDNESDAY, MAY 13.

ROYAL SOCIETY OF MEDICINE (Surgery—Sub-Section of Proctology) (Annual General Meeting), at 5.—Discussion on The Injection Treatment of Piles.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Human Monsters and Malformations (5): Malformations due to Irregular Implantation of the Ovum and to the Formation of Amniotic Adhesions.

INSTITUTE OF FUEL (at Burlington House), at 6.—Dr. A. Thau: Continuous Production of Water-Gas from Powdered Fuel.

TELEVISION SOCIETY (at University College), at 7.—H. Wolfson: The Development of Cuprous Oxide Photo-Electric Cells (Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS (Hampshire Sub-Centre) (at Portsmouth Municipal College), at 7.30.

ROYAL SOCIETY OF ARTS, at 8.—Major R. A. B. Smith: Architecture in Concrete on the Pacific Coast.

ELECTROPLATERS' AND DEPOSITORS' TECHNICAL SOCIETY (at Northampton Polytechnic Institute), at 8.15.—N. R. Laban: Problems in Chromium Plating and High Current Density Nickel Plating.

THURSDAY, MAY 14.

ROYAL SOCIETY, at 4.30.—Prof. H. Geiger, Lord Rutherford, and others: Discussion on Ultra-penetrating Rays.

LINNEAN SOCIETY OF LONDON, at 5.—Miss R. F. Shove: Dwarf Elm Tree (1909–1931).—A. J. Wilmott: A Botanical Tour in Spain.—C. F. A. Pantin: The Physiology of Variation.

LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5.—Prof. J. E. Lennard-Jones: Quantum Mechanics of Atoms and Molecules (Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—Commemoration of Centenary of the Birth of David Edward Hughes. Short Discourse on the Life and Work of Hughes by S. Evershed.—At 6.45.—Annual General Meeting.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 6.30.—C. Fritsche: The Metal-clad Airship.

IRON AND STEEL INSTITUTE (at Chamber of Commerce, Birmingham), at 7.—First Report on the Corrosion of Iron and Steel. Being a Report by a Joint Committee of the Iron and Steel Institute and the National Federation of Iron and Steel Manufacturers to the Iron and Steel Industrial Research Council.—O. Cromberg: Production Economy in Iron and Steel Works.—H. J. Gough and A. J. Murphy: On the Nature of Defective Laminations in Wrought-Iron Bars and Chain Links.—A. Robinson: The Melting Shop of the Appleby Iron Company, Limited.

OIL AND COLOUR CHEMISTS' ASSOCIATION (Annual General Meeting) (at 30 Russell Square), at 7.30.—W. D. Owen and A. M. Thomas: Properties of Synthetic Resins.

OPTICAL SOCIETY (Annual General Meeting) (at Imperial College of Science), at 7.30.—At 8.—Prof. G. P. Thomson: Electron Diffraction Phenomena (Lecture).

ROYAL SOCIETY OF MEDICINE (Neurology Section), at 8.30.—Annual General Meeting.

BRITISH INSTITUTE OF RADIOLOGY (Annual General Meeting), at 8.30.—Dr. H. S. Souttar: The Ideal Distribution of Radon Seeds.

FRIDAY, MAY 15.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 4.—Sir Arthur Keith: Human Monsters and Malformations (6): A Consideration of the Commoner Malformations to ascertain how far they can be explained by regarding them as Atavistic States or as due to Parental Influences.

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.—F. S. Grimston: The Indian Ordnance Factories and their Influence on Industry.

BRITISH INSTITUTE OF RADIOLOGY (Medical Meeting), at 5.

PHYSICAL SOCIETY (at Science Museum, South Kensington), at 5.15.—Sir Richard T. Glazebrook: Standards of Measurement: their History and Development (Guthrie Lecture).

INSTITUTE OF CHEMISTRY (Belfast and District Section) (at Royal Belfast Academical Institution), at 7.30.—Annual General Meeting.

ROYAL SOCIETY OF MEDICINE (Obstetrics and Gynæcology Section) (Annual General Meeting), at 8.—The Relative Value of the Induction of Premature Labour, Test Labour, and Cæsarean Section in the Treatment of Minor Degrees of Contracted Pelvis.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. J. C. Philip: Experimental Aspects of Hydrogen-Ion Concentration.

SATURDAY, MAY 16.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (Southern District Meeting) (at Cheltenham), at 10.30 A.M.

PUBLIC LECTURES.

FRIDAY, MAY 8.

LONDON SCHOOL OF HYGIENE AND TROPICAL MEDICINE (Public Health Division), at 2.—Dr. J. J. Buchan: Industrial Hygiène: The Rôle of the M.O.H.

LONDON SCHOOL OF HYGIENE AND TROPICAL MEDICINE (Public Health Division), at 5.—Sir George Newman: The Rise of Preventive Medicine (Heath Clark Lectures) (5).

MONDAY, MAY 11.

LONDON SCHOOL OF HYGIENE AND TROPICAL MEDICINE (Public Health Division), at 5.—Dr. C. F. White: Port Work.

TUESDAY, MAY 12.

LONDON SCHOOL OF ECONOMICS, at 5.—Prof. L. Hogben: Some Aspects of Human Inheritance (3): Mental Inheritance.

INSTITUTE OF PATHOLOGY AND RESEARCH (St. Mary's Hospital, W.2), at 5.—Prof. C. A. Ariens Kappers: The Function of the Various Layers of the Cortex.

WEDNESDAY, MAY 13.

LONDON SCHOOL OF HYGIENE AND TROPICAL MEDICINE (Public Health Division), at 5.—Dr. B. Hart: Mental Hygiene.

ST. THOMAS'S HOSPITAL, at 5.30.—Prof. G. Grey Turner: Resection of the Rectum. (Succeeding Lecture on May 15.)

THURSDAY, MAY 14.

GUY'S HOSPITAL MEDICAL SCHOOL, at 5.—Prof. W. R. Sorley: Science and Morals (Fison Memorial Lecture).

NATIONAL HOSPITAL FOR DISEASES OF THE HEART, at 5.—Sir Thomas Lewis: Ischæmia of Muscle as a Cause of Anginal Pain (St. Cyres Lecture).

FRIDAY, MAY 15.

LONDON SCHOOL OF ECONOMICS, at 5.—Lord Lugard of Abinger: British Rule in Tropical Africa. (Succeeding Lectures on May 18 and 19.)

LONDON SCHOOL OF HYGIENE AND TROPICAL MEDICINE (Public Health Division), at 5.—Prof. E. L. Collis: Industrial Hygiene: Respiratory Diseases.

IMPERIAL COLLEGE—ROYAL SCHOOL OF MINES, at 5.30.—Dr. H. de Böckh: Selected Chapters of Regional Geology and Tectonics. (Succeeding Lectures on May 19 and 21.)

KING'S COLLEGE, LONDON, at 5.30.—Col. the Master of Sempill: Air Communications of the British Empire.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Prof. E. L. Collis: The Coal-Miner: His Health and Occupational Diseases (1): Environment of Work (Chadwick Lecture.)

ANNUAL MEETING.

MAY 7 AND 8.

IRON AND STEEL INSTITUTE (at Institution of Civil Engineers), at 10 A.M.

Friday, May 8, at 10 A.M.—General Meeting.

Announcement of the award of the Andrew Carnegie Research Scholarships for 1931–32.

Announcement of the award of the Carnegie Gold Medal to Dr. E. Valenta.

Announcement of the award of the Williams Prize to F. Bainbridge.

Dr. W. Rosenhain and A. J. Murphy: Accelerated Cracking of Mild Steel (Boiler Plate) under Repeated Bending.

H. J. Gough and A. J. Murphy: On the Nature of Defective Laminations in Wrought-Iron Bars and Chain Links.

A. L. Norbury and E. Morgan: The Effect of Carbon and Silicon on the Growth and Scaling of Grey Cast Iron.

At 2.30.—V. Harbord: The Basic Process. Some Considerations of its Possibilities in England.

E. C. Evans, L. Reeve, and M. A. Vernon: Blast-Furnace Data and their Correlation.—Part II.

C. O. Bannister and W. D. Jones: The Sub-Crystalline Structure of Ferrite.

C. H. M. Jenkins and H. J. Tapsell: Some Alloys for Use at High Temperatures. Complex Iron-Nickel-Chromium Alloys. Part III.—The Effect of Composition and Exposure to High Temperatures.

Papers to be presented and discussed by correspondence:—

Sir H. C. H. Carpenter and J. M. Robertson: The Formation of Ferrite from Austenite.

J. H. Chesters and W. J. Rees: Refractory Materials for the Induction Furnace.

Dr. J. Newton Friend and W. West: The Resistance of Copper-Nickel Steels to Sea Action.

E. Ohman: X-Ray Investigations on the Crystal Structure of Hardened Steel.

G. Phragmén: X-Ray Investigation of Certain Nickel Steels of Low Thermal Expansion.