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The Future of the British Patent Office.

THE British patent system is a matter which concerns all workers in applied science, for it represents an attempt—faulty and incomplete, but still an attempt—to secure for such workers the credit for their achievements, together with a share of the material advantages arising from these. Hence any event which seriously affects the future of the patent system is one to which the scientific world should give careful consideration, and such an event is just beginning to appear on the horizon. Lest it should take shape before its implications have been seriously canvassed, it may be well to direct attention to some of its aspects. There is a rule which requires Government servants to submit to superannuation at an age when many men are still capable of their best work, and since the rule appears to be inexorably applied, the retirement of the present Comptroller of the Patent Office and the appointment of his successor must be regarded as inevitable in the not very distant future. It is perhaps a little early to discuss this question, but not too early; for when the first official intimation of such a change is given, the selection of the successor may be actually, if not formally, a *fait accompli*.

That a scientific office should have a scientific man at its head is a principle which seems obvious but needs to be constantly reasserted, because the administrative officials who influence such appointments are not always sympathetic towards the claims of science. In fact, a lack of sympathy in that direction is sometimes manifested to a degree which exposes it to strong criticism, as in the proceedings of committees A, B, and C of the National Whitley Council, and in the general tendency to regard the man of science as a mere adviser who is himself incapable of administrative work. Such an attitude is the more unjustifiable from the fact that a scientific training is necessarily always *additional* to some degree of education in the humanities, whereas a literary scholar may be quite ignorant of science; so that the former type of upbringing is the more likely to produce the breadth of outlook which is necessary in handling men and affairs.

Taking the British Patent Office as an example, let us examine the qualifications which are necessary in the man who is to direct its labours. The duties of the Comptroller fall under three heads as follows :

(1) He is the senior Hearing Officer for disputes as to patents, trade marks, and designs. He has to adjudicate in "oppositions" brought by interested parties against the grant of particular patents, as well as in cases where examiner and applicant fail to agree in regard to the official requirements put forward by

the former. Thus the Comptroller is a court of first instance for certain classes of patent litigation; and although he delegates this duty in a proportion of cases to subordinate Hearing Officers drawn from the examining staff, in the remaining cases he acts personally. For the adequate discharge of this function, the importance of which is obvious, the Comptroller should have legal knowledge, experience of patent practice, and such a wide training in scientific matters as to be able readily to appreciate, in the structure and functioning of electrical, mechanical, and chemical systems, those details and subtleties around which patent litigation so frequently turns. Should he lack the latter qualification, the new Comptroller would in many instances be thrown on the mercy of his advisers from the examining staff, and so would relinquish both his dignity and, in the case of disagreement between examiner and applicant, his judicial neutrality.

(2) He will command the staff of the Patent Office, in addition to those of the Trade Marks and Designs Branches. The essential work of the Patent Office is carried on by the examining staff, comprising (according to the last Annual Report) more than 250 men having the necessary scientific qualifications, while the routine incidental to their labours necessitates a supplementary staff comprising roughly an equal number of clerical workers. It would be unreasonable to subordinate the examining staff, in the years that lie ahead, to the control of a man who is not qualified, by a scientific training similar to theirs, to understand the outlook and the mentality with which such training is associated. It must be remembered that fundamental changes in the relative importance of the scientific and clerical sections of the staff have followed the changes introduced into the patent system by the Act of 1907.

(3) The new Comptroller will be called upon to advise the government of the day with regard to the improvement and extension of the patent system, which has certain unsatisfactory features, the chief being its incompleteness. It is incomplete because the official search is arbitrarily limited to British specifications, because it is imperfectly co-ordinated with other patent systems throughout the British Empire, and because adequate use is not made, for the benefit of national and industrial technology, of the special knowledge acquired by the examining staff (though the latter criticism does not apply to the War period, when many of the staff were drafted to the Ministry of Munitions). In the reconstruction of the Patent Acts the new Comptroller will play a pivotal part, and it is desirable, therefore, that he should have first-hand knowledge of the way in which the present system has worked in practice. Equally must he be a man of broad views and open mind, gifted with that sense of proportion and that *flair* for actualities which characterise the thinking of the quantitative and experimental sciences.

Where, it may be asked, is it possible to find a candidate possessing the necessary legal knowledge, scientific training, experience of patent practice, and largeness of outlook? Three classes of men immediately suggest themselves: (1) The patent bar, (2) the patent agents, and (3) the examining staff of the Patent Office itself. There are difficulties to be encountered in each case. As regards the third group, it is not the general practice of the Treasury to put at the head of a department a man promoted from within it, and we do not know in what circumstances exceptions to this rule are considered feasible. If the Comptrollership should be filled from within the Board of Trade, technical and not purely administrative attainments should decide the appointment. As regards the other two classes, the difficulty is that successful patent barristers and successful patent agents are able to make incomes many times greater than the salary attached to the Comptrollership. The dignity of the office might *perhaps* combine with the opportunity of public service which it offers to attract a man of the necessary calibre, but there is a fairer and wiser way to meet the difficulty in question. That way is, to raise the salary of the post to a level commensurate with the importance of the latter.

The public interest would suffer if the new Comptroller were to be a man whose lack of the requisite qualifications was only compensated by the possession of influential friends. Particularly would it be undesirable to fill such a post by promotion from the "administrative" or clerical grades of the Civil Service. There is a right place in the scheme of things for the bureaucratic mentality, but that place is not at the head of the Patent Office. While it is true that the business of the State could not be carried on without the meticulous observance of precedent, the mastery of complicated routine, the punctilio of official etiquette which are the special merits of the clerical civil servant, it is equally true that such gifts are not adequate to enlist the confidence of subordinates and of the public on behalf of the chief of a technical office already over-ripe for innovation and development.

Whatever decision may be taken when the time comes, it is earnestly to be hoped that no candidate will even be considered who does not combine with experience of patent practice a thorough training in physical science. It should be an absolutely inviolable principle that an essentially scientific staff should have a man of science at its head.

The Imperial College of Tropical Agriculture.

AT a luncheon at the Mansion House on January 29, given by the Lord Mayor of London and the governing body of the Imperial College of Tropical Agriculture, which is now getting into the swing of its work in Trinidad, Lord Milner's recent appeal for more funds for the endowment of the College was supported by a number of speeches which are of good augury for the future of scientific work in the British tropical colonies.

The Secretary of State for the Colonies (Mr. Amery), in proposing the toast of the College, said that it is an enterprise that holds out great hope in regard to the development of that great imperial asset, the tropical colonies. It is in this light that one should regard it—not as a local affair in Trinidad, but as an Imperial institution, the work of which will have a most important bearing upon the progress of our great tropical Empire. This has been much neglected in the past, though it has contributed so much to the wealth of the mother country—through sugar in the West Indies, coffee, coconuts, and tea in India and Ceylon, rubber in Malaya and Ceylon, jute, rice, and many other commodities in India.

From the wetter parts of our tropical possessions we obtain most of our supplies of cacao, cinchona bark for quinine, coconuts and their oil (for soap), copra, coir fibre, coffee, guttapercha, jute (for gunny bags), palm oil (for soap and lubricants), palm fibre (for brushes), rice, rubber, sago, spices, sugar, tea, tapioca, and many fruits, including the banana, and from the drier parts we obtain much tobacco and other products. Tropical Africa now bids fair to go far towards supplying Great Britain with cotton.

Such being the case, one might expect to find much money spent upon the development of the tropical colonies and everything connected with them (especially matters concerned with agriculture and its teaching). In actual fact, their development has largely been effected out of their own revenues, which are in general modest, as they depend mainly upon agriculture. An important departure from this method has recently been made, and the home Government has advanced a large loan to some of the tropical African colonies, with the express object of enabling a rapid development of their systems of transport.

With the great competitive extension of planting and of agriculture generally that is now going on in the tropics, the lack of appreciation of the importance of such an institution as the Imperial College must be due to want of thought. Surely this only needs to be pointed out for some of our wealthy firms and individuals, who have won prosperity from the great industries of rubber, tea, coffee, cotton, coconuts, and other products of the tropics, to come forward with important contributions towards the 100,000*l.* for which Lord Milner has appealed—an endowment to enable the College to make proper use of its great opportunities.

Let it be always remembered that the College is the Imperial College of Tropical Agriculture, and that it is to train men not for Trinidad alone, but for all the widely flung tropical dependencies of the British Empire. It has already received some munificent endowments, but is in need of many more. Its land and its largest cash endowment it owes to the Government of Trinidad. It has received machinery to the value of 20,000*l.* from the British Sugar Machinery Manufacturers, and has erected a model sugar factory. Messrs. Davidson and Todd, of Port of Spain, have presented the furniture, made of local woods, for the main hall of the College. Equipments for rubber, tea, cotton, and others are equally to be desired, and expert staffs are needed to manage them.

That important organisations are placing faith in the future value of the College is seen from the fact that the Empire Cotton Growing Corporation, with an executive council composed mainly of Lancashire business men, is sending many of its students to be trained there. These men will have in their hands the chief part in the development of this great industry within the British Empire.

One of the greatest desiderata in the proper opening up of our tropical possessions is a due care for health, and in this connexion it was of great interest to learn from the speech of Sir Arthur Shipley (chairman of the governors) that "the Trustees of the International Health Board (who control the Rockefeller endowments), after careful inquiry into the efficiency and standing of the College, have offered 1000*l.* a year for five years to establish a professorship of tropical sanitation and hygiene"; and if this proves a success, Sir Arthur has no doubt that they will continue their benefaction. This still further emphasises the need of the institution for further endowment and equipment.

With the opening of the Imperial College, the older methods of rule of thumb will tend to disappear in the light of modern scientific study, as they have all but disappeared in medicine or surgery. The chance for the young men of to-day, as against their predecessors of thirty years ago, is brighter to an almost incredible degree, provided that men of as good and as capable a type are ready to take advantage of it. Let us wish all prosperity to the Imperial College of Tropical Agriculture under the capable guidance of Dr. Hugh Martin Leake, its new principal, who has lately succeeded to the great pioneer of its fortunes, Sir Francis Watts.

Reminiscences of Great Naturalists.

Impressions of Great Naturalists: Reminiscences of Darwin, Huxley, Balfour, Cope, and others. By Prof. Henry Fairfield Osborn. Pp. xxviii + 216 + 12 plates. (New York and London: Charles Scribner's Sons, 1924.) 12*s.* 6*d.* net.

PROF. HENRY FAIRFIELD OSBORN, president of the American Museum of Natural History, distinguished especially for his palæontological researches, was one of Huxley's students and he also worked under Francis Balfour. He met Darwin and corresponded with Wallace; he was friendly with the combative Cope and very intimate with Roosevelt. So he has given us his impressions of these and others, selecting a dozen out of the fifty-seven "appreciations" which he has written in the course of his busy life. He has indulged his liking for trying to sum people up; and he has cultivated the gift, he tells us, by studies in heredity and racial characteristics and our ancestors of the Old Stone Age. For with his studies there has grown the conviction that "our intellectual, moral, and spiritual reactions are extremely ancient, and that they have been built up not in hundreds but in thousands—perhaps hundreds of thousands—of years." This palæontographical line of thought is very suggestive; thus we think of Pasteur as the supreme avatar of the tanners, and of Roosevelt as the glorification of the hunters; but we do not find that Prof. Osborn has allowed it much expression in his book, unless in "the racial soul of John Burroughs."

We suspect that the greater part of the success of Prof. Osborn's pictures is due not to any theoretical background, but simply to the fact that he is a large-hearted, open-minded, big-brained naturalist himself, a generous rather than critical painter, who instinctively looks for what is best in his sitters. If we ever rise to having our portrait painted, we shall hope to have it done by Prof. Osborn. But they allow you little say in such matters. Here, however, is a truly delightful book of impressions, marked by insight, balanced judgment, and humour.

Wallace's portrait must always be difficult, he was so unequal: with a passion for truth-seeking, yet led astray by will-o'-the-wisps; an observer of the highest rank, yet wasting time in trying to prove to fools that the earth is not flat; a serious ponderer over the mysteries of life, yet often far from clear-cut in his thinking—say, over sex-selection or the possible origin of man's musical talents. One of the noblest men we ever met, one of the foundation-layers of modern biology, yet least wise, we think, when he differed most from Darwin. But the immediate point is that Prof. Osborn gives us a beautiful picture of this great servant of the truth.

Osborn was dissecting a lobster in Huxley's laboratory when Darwin came along and gave him a friendly greeting. "He stands much taller than Huxley, has a very ruddy face, with benevolent blue eyes and overhanging eyebrows. . . . My general impression of his face is very pleasant." He had the eyes of "a man who could survey all nature." Perhaps this last sentence gets to the heart of the matter. Darwin's greatest gift was his capacity for unified vision, for seeing things whole. He could take in such a comprehensive landscape that the fallacy of partial views was escaped. Doggedly, as he says, he gathered his facts until their multitude would have overwhelmed most men; gathered them and gazed at them and tested them, until the ever-lurking generalisation took the form that fitted and made them one. Whoever has come near Darwin in the all-round comprehensiveness of his picture of the struggle for existence, the inter-relations of organisms, or the processes of selection? The reason why he remains, on the whole, so sound is given by Osborn: "His eyes were the eyes of a man who could survey all nature." He speaks also of their "translucent truthfulness," and in his palæontographical vein he refers to the fact that Darwin came of "a long line of compellingly truthful ancestors." As we expected, Osborn gives a robust answer to the question: How stands it with Darwinism to-day? He indicates the developments of Darwinism that are in progress, including, of course, some corrections, but his general view is that Darwinism is going on and going strong. We do not, however, agree that Darwin's supreme service was that "he won for man absolute freedom in the study of the laws of nature," for that halo belongs to no single emancipator.

Prof. Osborn is at his best in painting Huxley. He brings out his lucidity, his fighting qualities, his loyalty as "Darwin's bull-dog," his powers of brilliant generalisation, his capacity for taking pains, his passion for veracity. Huxley's discernment of affinities has left many a deep mark on zoology. Here were steps of generalising insight of the highest order, and yet "he never contributed a single original or novel idea" to the Darwinian theory. Prof. Osborn regards this as an expression of Huxley's scientific caution—he could not make up his mind to an ætiology (to use his own word); but perhaps it simply meant that his originality and synthetic power found in morphology and taxonomy all the expression that his busy life would allow.

Francis Maitland Balfour was "the most brilliant and lovable of men," "by far the most balanced mind

among all the English biologists"; he set comparative embryology on its feet. But the picture that is given of him is not more than an elusive sketch. There is more body in the contrasted pictures of Joseph Leidy and Edward Drinker Cope, "the very last representatives in America of the older school of naturalists and anatomists, who covered a very broad field." Leidy was essentially a man of peace, Cope a militant palæontologist. Leidy was an exact observer—a Cuvierian; Cope revelled in speculation, with the strands of Lamarck in his intellectual fabric. Leidy was an evolutionist *sub rosa*; Cope radiated evolution from his eyes.

It is very interesting to see how impartially enthusiastic Osborn is in portraying the divergent excellencies of his old friends. His book contains some good stories, and here is one about Cope. A difference of opinion with his friend Persifor Frazer at the American Philosophical Society "led to such a violent controversy that the two scientists retired to the hallway and came to blows! On the following morning I happened to meet Cope and could not help remarking on a blackened eye. 'Osborn,' he said, 'don't look at my eye. If you think my eye is black, you ought to see Frazer this morning!'" We begin to understand better why Osborn insists that we must go back to the Old Stone Age if we are to understand one another. We are glad to be assured, however, that such differences of opinion did not sever the lifelong friendship.

We wish we had left room to speak of the other portraits: of Roosevelt, with his suggestion of tremendous grip—we remember his hand-shake still—and his accurate knowledge of birds and mammals; of James Bryce, keen botanist and geologist, as well as mountain-climber and historian, who died young at eighty-three; of Howard Crosby Butler, the archæological explorer; of John Burroughs and of John Muir (we are ashamed to confess that we never heard of him before), and of Louis Pasteur, who "showed the way to the physical redemption of man, as Newton had opened to us the new heavens and Darwin the new earth." He should stand as "a symbol of the profound and intimate relation which must develop between the study of nature and the religious life of man." Prof. Osborn's portraits are accompanied by very interesting photographs, and the two series throw light on one another. It is one of the most interesting books we have read for some time, provoking reflection, as well as pride and humility. Our only serious criticism is the author's tendency to be too generous. After all, was there a real genius amongst them—we mean a maker of new knowledge that makes all things new? No doubt Charles Darwin discovered a New World, but there were explorers before him as well as before Columbus, and the doctrine of evolution was not created at Down. They were giants these men here portrayed, but, seriously, when we think of it, would we compare any of them intellectually to Newton or Faraday, to Clerk Maxwell or Kelvin? We doubt if biological science has in the past enthralled any minds of the first order of magnitude, except men like Aristotle, Descartes, and Goethe, who could do everything well. So while Osborn asks if we could nurture a mind like Darwin's to-day, and is inclined to answer in a sad negative, our impression is that we may not unreasonably hope to nurture something even better.

J. ARTHUR THOMSON.

Modern Views on Cytology.

General Cytology: a Textbook of Cellular Structure and Function for Students of Biology and Medicine. By Robert Chambers, Edwin G. Conklin, Edmund V. Cowdry, Merle H. Jacobs, Ernest E. Just, Margaret R. Lewis, Warren H. Lewis, Frank R. Lillie, Ralph S. Lillie, Clarence E. McClung, Albert P. Mathews, Thomas H. Morgan, Edmund B. Wilson. Edited by Edmund V. Cowdry. Pp. vii+754. (Chicago: University of Chicago Press; London: Cambridge University Press, 1924.) 7.50 dollars.

THIS volume—the largest and most comprehensive ever published on the subject of cytology—will stand for many years to come as the most authoritative exposition of a branch of zoology which has grown considerably in recent years. It has been written by the foremost cytologists in the United States of America, altogether thirteen workers, eminent in their special branch, having collaborated. The task of editorship was discharged by E. V. Cowdry.

Such a work could not have been written by one man, and it is obvious that no one reviewer can do justice to such a monument of learning. The present reviewer is keenly aware of this, and would have wished, had it been possible, to have had a sectional review, assisted by English cytologists such as Ward Cutler, Agar, Gray, Ruggles Gates, and Heslop Harrison.

Prof. A. P. Mathews in his section discusses "Chemistry and Psychism," and comes to the conclusion that the creation of life is the creation of the "anakinetomeric form," *i.e.* energy-rich type of substance. Prof. Mathews writes:

"It is in fact the luminiferous ether which has made things alive, for ether is the great storehouse of energy; it is itself nothing else than space and time; energy and time. Energy is but ether divided by time. Quantity of energy is quantity of ether per second. So all goes back to the ether; infinity and eternity. From it is derived our energy and life."

It is impossible for a working cytologist adequately to comment on such passages. They may mean something to the metaphysician, but one cannot help feeling that Prof. Mathews' views on the relationship between cell lipins and cell proteins, or on the biochemistry of development, would have been more useful.

The biochemist writing on the subject of the chromosome theory is always interesting. Prof. Mathews plainly, if cautiously, states that it would be difficult for the biochemist to accept the factorial hypothesis on the evidence of chemical analyses of the chromatinic heads of spermatozoa and other nuclei. He points out that it is very improbable that were the chromosomes constituted of widely different genes, they would show so simple and definite a composition.

This is precisely where modern biochemistry fails: it has not kept up with either genetics or descriptive cytology, and probably never will until microchemical methods are more extensively developed. The statement made by Prof. Mathews that the spermatid nucleolus disappears during spermateleosis is without doubt incorrect. What happens is that the nucleolar and chromatinic substances come to stain with equal intensity.

M. H. Jacobs contributes a section on the permeability of the cell to diffusing substances: he deals especially with the modern work on intravital staining, and the penetrating powers of various salts and organic compounds. This article should be of the greatest value to cytologists working with *intra vitam* methods, and the part dealing with the subject of dyes, if short, is particularly pertinent: this chapter, as also many others in this book, shows clearly how indeterminate has been a great deal of recent experimental work. The modern zoological experimenter seems able to produce published papers more quickly than any other of his fellow zoologists; such work, carried on without a proper knowledge of the chemical and physical factors involved, is worse than useless. Jacobs' article shows that there is still a great field for examination in cell permeability, but the searcher *must* be properly equipped. Jacobs refers often to the "Donnan equilibrium."

It would be difficult to set proper boundaries to the subject of the reactivity of the cell. Naturally Ralph S. Lillie's section on this subject is somewhat diffuse and deals with much of his well-known work on the transmission of impulses by protoplasm, and especially with the transmission of nerve impulses. As has been remarked with regard to Jacobs' section, this part by Lillie will certainly be of value to cytologists interested in intravital work, and to protozoologists. The basic work on the irritability of plants, such as that of U. Ricca, R. Snow, and H. H. Dixon, is not mentioned.

The editor of the volume, E. V. Cowdry, has written a section on the mitochondria, Golgi apparatus, and chromidial substance. The article is well balanced if a little histological: the contributions of the English workers on the cytoplasmic inclusions in gametogenesis are adequately mentioned, though the whole question of gametogenesis itself is untouched. This can be forgiven in view of the splendid treatment of the pathological side of this important branch of cytology. So much of our meagre knowledge of the function of the cytoplasmic inclusions has been ascertained by studies on gametogenesis, that it seems a pity that Dr. Cowdry did not include a full treatment of the subject. Some of the controversies regarding the inclusions in gametogenesis would surely have been settled had so distinguished a worker as Cowdry seen fit to enter into the field.

The much-abused Golgi apparatus has at last received official recognition. For this the reviewer at least is thankful. Cowdry mentions that the Golgi apparatus does not occur in non-nucleated red blood corpuscles: it occurs in the red blood corpuscles of reptiles and birds, as has recently been shown. With the possible exception of certain Protozoa, the Golgi bodies have been found in all nucleated animal cells at some time in their life-history.

Warren Lewis and Margaret Lewis are so well known for their work in tissue cultures, that one would be led to expect an authoritative account on this subject; nor are we disappointed. This section contains the best photomicrographs of cells published anywhere. Champy's interesting claims with regard to dedifferentiation of cells cultivated *in vitro* are not substantiated by the Lewises.

The most interesting recent discovery with regard to fertilisation is the process as it occurs in the sponge Grantia. Here somatic cells are entered, and the spermatozoon swells up and becomes spherical before it is finally carried to the egg. These facts are not mentioned in Lillie and Just's section on fertilisation, nor are the peculiar examples of precocious fertilisation reviewed. The entry of the somatic cells in sponges, mammals, and leeches by spermatozoa is not dealt with; this is a pity, because these facts have a very direct bearing on Lillie's fertilisation theory. The more physical side of fertilisation is adequately treated, but the article as a whole suffers from the fact that the authors have not dealt properly with the work of descriptive cytologists such as Jenkinson on the axolotl.

Conklin contributes a suggestive section on cellular differentiation. Some of the continental work on histogenesis, mentioned in NATURE, February 23, 1924, pp. 276-278, has not come up for review, and the physio-

logical aspect is not dealt with; cell-lineage, a branch of cytology inseparably coupled with Conklin's name, is naturally treated exhaustively. To explain the old question of cellular differentiation, Conklin assumes the presence of differential factors of development lying outside the nucleus, such areas being themselves the immediate result of the interaction of the cytoplasm of the nucleus at an earlier stage. Such an assumption certainly explains partly some forms of development, but not all, and the main question is still unanswered.

In the last two chapters we have an account by McClung of the modern aspects of the chromosome theory, and another section by Morgan dealing with his wonderful work on Mendelian heredity. The recent English work on sex-reversal and the so-called suppression of the sex-chromosome is not properly dealt with, and should be included in the next edition.

Some of the sections gain, others suffer, from the personal theories of the authors. On the whole, the bibliographies are as complete as could be desired, and the illustrations are a feature of the work. The book begins with an introduction by E. B. Wilson, the best-known living cytologist, whose work on "The Cell" has been the students' standby for so many years. In a footnote, Prof. Wilson mentions that he is bringing out a new edition of his work. "General Cytology" is a splendid testimony to the high standard of American science, and cytologists on the eastern side of the Atlantic should be full of admiration and properly grateful for such a splendid volume.

J. BRONTË GATENBY.

General Chemistry.

(1) *Introduction to General Chemistry*. By Prof. William Foster. Pp. vii + 643 + 29 plates. (Princeton: Princeton University Press; London: Oxford University Press, 1924.) 17*s*. 6*d*. net.

(2) *A Laboratory Manual in General Chemistry*. By Prof. William Foster. Pp. ix + 205. (Princeton: Princeton University Press; London: Oxford University Press, 1924.) 10*s*. net.

(1) PROF. FOSTER'S volume was printed in an experimental form two years ago and used by nearly 1000 students before being finally revised for publication. It is a very crowded volume, but at the end of each chapter there are references to the sources of the material, which the student is recommended to read for fuller information. It is no small compliment to English authors that the books cited for this purpose are in the great majority of cases the standard works used in Great Britain. This statement applies, not only to the larger text-books, such as those of Roscoe and Schorlemmer, of Mellor and of Friend, the first of which must have provided the materials for scores of smaller works, but still more frequently to the recent single-volume text-books of Lowry and of Partington, which are repeatedly cited in this way.

The chief fault of the book is its extreme compression, which gives the whole volume the appearance of a reprint of a student's notes on lectures, rather than of the lectures themselves; an independent reader would therefore find the book very tiring, but a student already attending a course of lectures could use it with comfort to supplement his own notes, and to recall in a more authoritative form what he had already been taught by word of mouth. The author has, however, been quite lavish in certain directions, notably in supplying 26 full-plate illustrations of distinguished chemists; these are admirably reproduced, and are in marked contrast to the rough line-drawings in the text, and to the printing, which is on paper of such transparency that it is often possible to read words which are printed on the other side of the sheet, with the result that the pages give the impression of being smudged. In two other cases the text is fuller than in the majority of similar books, since statistics of production are given, for example, for steel and copper, where the United States are at the head of the list; and, in connexion with the metallurgy of copper, the author has allowed himself two full-page photographs and a full-page diagram, in addition to two pages of text, to illustrate the smelting and refining of the metal.

The earlier chapters are, as a rule, provided with a summary, and exercises on the chapters are given throughout, culminating in a series of more than 200 problems at the end of the volume. The diligent student may therefore be expected to have acquired considerable skill by the time that he has completed the course; but the book is designed for "high pressure" work, and "low pressure" readers would probably prefer to choose some less strenuous compilation.

(2) Prof. Foster has also compiled a Laboratory Manual, the material for which has been secured during nearly twenty years of actual teaching, and revised from year to year in such a way as to anticipate every possible misunderstanding on the part of the student. The book concludes with an ingenious "preliminary exercise" on the separation of the metals into groups, in the course of which 24 test-tubes of solutions, arranged in alphabetical order, are attacked successively by the familiar group-reagents. The work of compilation has been done well, and the work will be helpful to other teachers who are responsible for practical classes in elementary chemistry.

Our Bookshelf.

Quantitative Organic Micro-analysis. By Prof. Fritz Pregl. Translated from the second revised and enlarged German edition by Dr. Ernest Fyleman. Pp. xv+190. (London: J. and A. Churchill, 1924.) 12*s.* 6*d.* net.

THE quantitative analysis of minute amounts of organic solids and liquids is an art (or should we say handicraft?) which owes more to Prof. Pregl than to any other worker, and the award of a Nobel prize to him a few years ago was a fitting tribute to his successful services in this field. At present confined almost exclusively to biochemistry (where it will be useful when the elusive vitamin is isolated), organic micro-analysis has an important future before it.

After devoting a chapter to the Kuhlmann balance, a marvellous instrument which weighs to ±0·001 mgm. at maximum load (20 gm.), the author describes the determination of carbon and hydrogen, nitrogen, the halogens, sulphur, of arsenic, phosphorus, and copper in organic combination, of the carboxyl, methoxyl, ethoxyl, and methyl groups, and adds a chapter on the determination of molecular weight by the boiling-point method. The weight of material required for each analysis is about 12-15 mgm.

The micro-methods have many points of similarity with the older classical methods of Liebig, Dumas, and Carius, and have obviously been developed from these by dint of tremendous patience and devotion to detail, as well as of unusual practical skill. These newer methods demand a very special technique, the acquisition of which would provide a valuable training to the student after—not before—he has mastered the principles and practice of ordinary analysis. Technique is, as a rule, best learnt in the laboratory from a colleague or instructor, not from a text-book; but in the present case the use of a text-book is fully justified, because organic micro-analysis is still very little known in Great Britain, and also because the directions given by Pregl are so detailed, that it is difficult to conceive how any well-trained chemist could fail to learn from them.

One does not, of course, look for literary skill or grace in a work of this kind; and one does not find them. Like most German technical treatises, the style of this work is heavy, and the translator, of set purpose, has not lightened it. As a literal translation the English version is good, but it would have been much better if the German style had been less rigidly reproduced. "Pregl" is an important work, and both publisher and translator deserve our thanks for having made it available to the increasing number of chemists who either cannot read German, or cannot read it with ease or pleasure.

The Heavens. By J. H. Fabre. Translated by Dr. E. E. Fournier d'Albe. Pp. xvi+336+16 plates. (London: T. Fisher Unwin, Ltd., 1924.) 15*s.* net.

FOR lucidity of style, for simplicity of language, and for felicity in illustration, this book on descriptive astronomy is probably unique. Many passages are quite poetical, as, for example, that (pp. 90, 91) on morning, noon, and night, while the charm of others, such as the concluding paragraphs of the lesson on hour and longitude, lies in their wealth of descriptive allusions. Even the elementary mechanics becomes absorbing when clothed in such vivid language, and the explanation of how the earth is weighed, and of such subjects as parallax, inertia, and centrifugal force, are presented in a most attractive style.

The work is divided into twenty-five lessons, or chapters, and of these all, except three, are concerned with the solar system, and principally with an elementary presentation of its mechanics. There is a preliminary lesson on simple geometry, and by the employment of these "modest geometrical studies" the earth is surveyed, and is weighed, the Cavendish experiment being very clearly explained. It is then girdled with circles of latitude, and with meridians of longitude, its rotation is made clear, and the effects of the illumination of the atmosphere and of the refraction of light are applied. There is also a very good chapter on the calendar. These are specimens of the topics dealt with, and there are also chapters on the sun, the moon, the planets, the comets, the fixed stars, and the nebulæ.

The translation is very well done, and there are several notes by the translator to bring the matter in the text up-to-date. But we think that it would have been an advantage had the translator also edited out-of-date statements in the text, as, for example, that Uranus has eight satellites, that the best method of determining solar parallax is by the transit of Venus, as also the distances in light-years given for some of the stars, which are founded on antiquated data. The name Herschel is always wrongly spelt. There are other obvious slips, probably due to faulty proof-reading. A. L. C.

British Antarctic ("Terra Nova") Expedition, 1910. Natural History Report. Zoology, vol. 8, No. 1: *Crustacea.* Part 8: *Euphausiacea.* By Prof. W. M. Tattersall. Pp. 36 + 2 plates. (London: British Museum (Natural History), 1924.) 5*s.*

THERE are very few groups of invertebrate animals of which it can be said with any probability that nearly all the existing species have now been discovered. This claim was made some years ago by Dr. H. J. Hansen as a result of his extensive studies on the Crustacea of the order Euphausiacea. It is supported by the fact that, in the report on the very large collections of this group made by the *Terra Nova* expedition, Prof. Tattersall has not found it necessary to describe a single new species. He discusses the characters and synonymy of a number of the species and describes a series of the larval stages of *Euphausia longirostris*, which is shown to differ from some of its congeners in having a prolonged larval life and in reaching an unusually large size before assuming the adult form. A considerable part of the memoir is devoted to discussing the distribution of the species obtained in the three areas chiefly explored, the Atlantic, the New Zealand region, and the Antarctic and Subantarctic zones south of New Zealand.

It is pointed out that nearly all the specimens were taken in the surface waters at night. During the daytime very few euphausians were taken, and these were, for the most part, larvæ. While a daily vertical migration to and from the deeper strata of the ocean

has been definitely shown to occur for some species, and is probably characteristic of the epiplanktonic species in general, this explanation does not apply to all cases. In coastal waters, euphausians are sometimes observed at the surface in daylight, and their absence from the tow-net catches may be due to their being able to see and avoid the slowly moving tow-nets. The "full speed" nets used on the *Terra Nova* do not seem to have been efficient for the capture of such comparatively large organisms.

Les Insectes parasites de l'homme et des animaux domestiques. Par E. Séguy. (Encyclopédie pratique du Naturaliste, tome 18.) Pp. 442. (Paris: Paul Lechevalier, 1924.) 30 francs.

FRANCE has produced many notable parasitologists, and Brumpt, Neveu-Lemaire, Blanchard, and Ralliet are familiar names of authors of text-books on their subject. M. Séguy is chiefly known as a dipterist, and his studies on mosquitoes have evidently led him to embrace the wider field of parasitology. Although only five orders of insects directly affect man or his domestic animals, a vast literature has grown around them, and the task of treating them at all adequately from the aspect of parasitology is an unusually heavy one. The handbook of M. Séguy is notable as a very concise and practical illustrated epitome of the subject. He has succeeded in compressing within its small compass a really large amount of accurate information.

The Diptera, being the largest order the parasitologist has to contend with, naturally comes in for the major share of treatment. In dealing with this group, the author adopts the heterodox classification of Lameere, who divides the order into only Nemocera and Brachycera. The latter sub-order is made to include the Nemocera Anomala of Osten Sacken, the Brachycera and all the Cyclorrhapha of the more usual systems. This feature renders the section devoted to Diptera rather difficult to follow until one's previous ideas have been readjusted accordingly. The Mallophaga, Anopleura, and Aphaniptera are also adequately dealt with, but among the Hemiptera the Reduviidæ are perhaps dismissed rather too summarily. The book concludes with a well-chosen bibliography of more than 300 references, which, along with the numerous footnotes, includes most of the important sources of information. A. D. I.

The Romance of the Apothecaries' Garden at Chelsea. By Dr. F. Dawtrey Drewitt. Second edition. Pp. 136+15 plates. (London and Sydney: Chapman and Dodd, Ltd., 1924.) 5*s.* net.

How many persons pass daily by the modest botanical garden in Swan Walk, Chelsea, in blissful ignorance of its origin, its antiquity, and the romance attached to it. Dr. Drewitt's charming little work would tell them that it was established about 1673 by the Society of Apothecaries in order that their apprentices might make themselves familiar with the plants used in medicine that, later on, they would be prescribing for their patients. It would give them an insight into the separation of the Apothecaries from the Grocers, of the opposition the new Company had to face, the vicissitudes through which it had to pass, and the sacrifices it had to make to maintain its garden. Dr. Drewitt has understood how to weave into his account much of the changes that London and the surrounding villages have undergone during the last three centuries. He tells us of Johnson, Miller, Sir Hans Sloane, Sir Joseph Banks, and other celebrated men who did so much for the Garden, which attained so high a reputation that, as a letter written by a friend of Linnæus to Miller when curator clearly shows, it was the Apothecaries' Garden which brought Linnæus to London. The second edition of the book contains many additional details concerning the history of the trees in the Garden, so that even any one accustomed to use it for the purposes of study will take a far greater and more intelligent interest in it. The book is most fascinating, and can be read again and again with pleasure and profit.

The Kinetic Theory of Gases. By Prof. Eugène Bloch. Translated by P. A. Smith. Pp. xiv+178. (London: Methuen and Co., Ltd., 1924.) 7*s.* net.

THIS translation, which is taken from Prof. Bloch's work, dated 1921, should meet with a welcome from English readers. The work contains a large amount of information on subjects which commonly find no place in the average text-book. Recent investigations have made the kinetic theory of fluids one of the most vital branches of theoretical physics. Experimental progress has gone hand in hand with the development of theory. There are interesting chapters on statistical mechanics, the theory of quanta, and the Brownian movement and fluctuations. At first sight the width of spectrum lines scarcely seems related to the subject of the book, but the author shows clearly how the width depends on the collisions of the molecules and on their thermal motions. The translator, who has done his work in a very satisfactory manner, has prepared a more complete bibliography of recent papers dealing with the subjects discussed in the various chapters of the book.

Hellenistic Philosophies. By P. E. More. (The Greek Tradition from the Death of Socrates to the Council of Chalcedon, 399 B.C. to A.D. 451, Vol. 2.) Pp. v+385. (Princeton: Princeton University Press; London: Oxford University Press, 1923.) 13*s.* 6*d.* net.

THIS is the second volume (the first dealt with the religion of Plato) of a notable comprehensive account of the Greek philosophical tradition. In Mr. More's view, it ends in scepticism, but arises to new life in Christianity. Two other volumes carrying on the tradition are promised. Mr. More writes with ease and distinction and the book is beautifully printed. The absence of an index seriously handicaps it as a book of reference.

Practical Organic Chemistry. By Prof. Julius B. Cohen. Third edition. Pp. xv+520. (London: Macmillan and Co., Ltd., 1924.) 6*s.* 6*d.*

STUDENTS of organic chemistry are indebted to Prof. Cohen for a series of excellent text-books, and this revised edition of his "Practical Organic Chemistry" reaches a high standard. It covers a wide field, including biochemical preparations, and references to the literature are given. A good feature is the very instructive collection of explanatory notes. The book may be recommended as by far the best in any language, and the price is most reasonable.

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.*]

The Origin of Sponge-Spicules.

To account for the extraordinarily beautiful and varied forms of sponge-spicules, with their wonderful symmetry, has long been one of the most puzzling problems of the zoologist. After more years of investigation than I care to number, I have arrived at certain conclusions that may interest the readers of NATURE. It is, however, a long story, of which I cannot here give more than the barest outline, to be followed, I hope, by a fuller account in another place. For the sake of brevity I must also confine my remarks almost exclusively to siliceous spicules.

The generally accepted idea that these spicules arise in "mother-cells" must be abandoned, the so-called mother-cells being, in fact, cells which have enveloped the growing spicule secondarily, after the fashion of phagocytes. Their function is either, as silicoblasts, to deposit silica upon the spicules, or, as simple amœbocytes, to carry them from place to place. The primary axis around which the silica is deposited is the protorhabd (axial thread), represented in old and eroded spicules by the axial canal. The origin of the protorhabd has hitherto been a complete mystery. I believe that it begins as a very minute granule, resembling a micrococcus, capable of movement from place to place, of multiplication by fission, and of growth by elongation and sometimes branching. Regarded as quasi-independent organisms, living symbotically with the sponge, these granules may be termed sclerococci; looked on simply as spicule initiators, they may be termed scleroplastids. Around the usually much elongated scleroplastids, or protorhabds, concentric layers of silica are deposited by silicoblasts, which associate themselves temporarily with the spicules for this purpose, and may exercise a mechanical influence upon their form.

The number and arrangement of the rays of the spicule depend upon the number of divisions of the original scleroplastid and the positions which the products of these divisions take up. In the tetract spicule, for example, the original scleroplastid divides into four, which arrange themselves in the form of a pyramid and then elongate centrifugally. Secondary growing points may be established by other scleroplastids settling down upon the young spicule and forming new centres of silica deposition.

The evidence on which these conclusions are based can only be summarised in the briefest manner.

(1) In *Stelletta hæckeli* we find many abnormal tetracts (triænes) with more or less suppressed rays, forming a well-graduated reduction series, the protorhabds (still indicated by the axial threads), having been checked in their growth and completely enveloped in silica at various stages of elongation (Fig. 1, 1-5). This reduction series culminates in a perfect sphere of concentrically laminated silica (Fig. 1, 6), with a minute granule, representing the original scleroplastid, in the centre. Such spheres are not infrequently met with in siliceous sponges and have been called "siliceous pearls."

(2) Abnormal spicules are often found with adventitious rays developed in unusual situations, and sometimes distinguishable as shafts and cladi. These are to be explained on the hypothesis that wandering scleroplastids settle haphazard on the young spicule and there initiate each its own special kind of ray. In Schmidt's *Stelletta pathologica* nearly all the larger spicules are quite abnormal, formed of rays that have come together apparently by chance, like the members of an Empedoclean monster.

(3) The amphitriæne, which occurs rarely, and usually, if not always, as an abnormality, is readily explicable as a case of incomplete twinning due to abnormal but symmetrical divisions of the original scleroplastid.

(4) I suggested some years ago that in certain spicules with whorled outgrowths the whorls are initiated by groups of "formative" or "initial cells," which settle on the nodes of a vibrating rod, a conclusion which was mathematically supported in a very striking manner by Prof. J. W. Nicholson. These so-called initial cells are really very minute growing points, in each of which a scleroplastid probably forms a centre of attraction for the silica. In the anisodiscorhabds of *Latrunculia bocagei* there are normally two tripartite whorls, each with three growing points. Cases of complete twinning sometimes occur, in which two such spicules, of greatly reduced size, develop

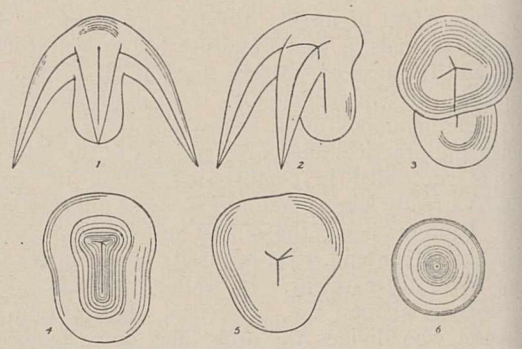

FIG. 1.—Suppressed tetract spicules (triænes) of *Stelletta hæckeli*. ×140.

side by side, but each of these twins has only one whorl. This indicates very clearly that the scleroplastids initiating the two whorls have undergone the usual number of divisions but that their products have distributed themselves over two spicules instead of one.

This last observation seems to me conclusive as to the existence of the scleroplastids as mobile and dividing granules of extremely minute size. The evidence that these are symbiotic organisms (sclerococci) is admittedly less convincing, but seems to me fairly strong.

(1) It is well known that along various lines of phylogenetic descent entire spicule categories mysteriously drop out. Thus we have Stellettids that have lost their triænes, Desmacidonids that have lost their chelæ, and so on. In Chondrilla all the megascleres have disappeared, and in Chondrosia there are no spicules left at all. I was formerly inclined to attribute this loss to the dropping out of Mendelian factors. It may be more simply explained as being due to non-infection by sclerococci.

(2) Various cases of the abnormal occurrence of particular types of spicule may be explained by abnormal infection.

(3) In the Euceratosa, with the exception of Darwinella, there are never any spicules at all. Darwinella, however, has, in addition to the normal horny skeleton, radiate spicules composed of spongin, presumably deposited around protorhabds.

(4) In many species of Mycale and Esperiopsis three types of chelæ occur. This may be interpreted to mean that the sclerococci sometimes conjugate and occasionally hybridise, so that we get the two parent

forms of chela and a hybrid. But more evidence is required before this view can be definitely established.

It is difficult to regard the scleroplastids (sclerococci) as genuine constituents of the sponge. They are not nucleated cells but seem to resemble Bacteria in many respects, and I suggest that they are handed on from generation to generation of sponges by egg-infection. The sponge converts many of these symbionts into spicules (siliceous, calcareous, or horny as the case may be), and then makes use of the larger ones by building them up into a more or less regular skeleton. The smaller ones it usually makes no use of at all, but either removes them by means of phagocytes or leaves them scattered irregularly through the soft tissues. It may be suggested that it is a case of parasitism rather than symbiosis, but evidently the sclerococci are not all destroyed by the sponge, and both parties probably benefit by the association.

Experimental investigations by means of inoculation and so forth remain to be attempted, and I hope that this communication may serve to direct attention to a new and promising field of research. The fact that naked sclerococci have not yet been recognised may very well be due to the difficulty of distinguishing them from ordinary Bacteria and from other minute granules with which the tissues of sponges abound.

ARTHUR DENDY.

King's College, London,
January.

On the Excitation of Spark Spectra.

THE great number of unsuccessful attempts to observe a spark spectrum of lithium have proved the difficulty of exciting, by means of the ordinary methods, the spark spectrum of an element when the excitation potential is high compared with that of the arc spectrum of the same element. Owing to the great interest which is attached not only to the lithium spark spectrum, but also to many other spark spectra which have hitherto not been observed, experiments have been carried on at this Institute during the last two years with the purpose of developing a method which should make it possible to produce spark spectra having a high value of the excitation potential. An apparatus was designed, in which the vapour of the element under investigation was allowed to escape into a high vacuum from a little hole in a crucible, heated by an electric furnace, and where this vapour could be exposed to a bombardment by a strong current of electrons. By evacuating the apparatus to a pressure below 0·001 mm., and by means of a special design of the orifice of the crucible, it was possible to produce and accelerate these electrons, before they could collide with the atoms of the escaping vapour. In the latest construction of the apparatus, the distance from the tungsten filament to the grid was 1-2 mm., the distance from grid to the crucible 10-15 mm., and the electron current was, by means of an anode behind the crucible and a ring near the grid, concentrated on the hole of the crucible where the concentration of vapour was a maximum. The electron current was usually of the order of 200-300 ma, but could without difficulty reach more than 500 ma. Accelerating voltages up to 1400 volts have been applied.

In the first experiments the crucible was filled with easily evaporated metals like sodium, potassium, cadmium, and zinc, and promising results were obtained. Besides the arc spectrum, which was always fully developed with high members of the series, the spark spectra of these elements were observed with considerable intensity at low accelerating potentials of a few hundred volts. Also, with salts in the crucible, spark spectra were in various cases obtained without difficulty.

Owing to the very high boiling-point of metallic lithium and the small dissociation of its salts, it was not found possible in the first apparatus, where the crucible could not be heated above 600°, with this element to produce a sufficient high vapour pressure. With a redesigned apparatus, in which the crucible could be heated to 1000° C., we succeeded, however, in obtaining several lines of the lithium spark spectrum which appeared with considerable intensity with an accelerating voltage of about 300 volts.

While this second apparatus was under construction, Schüler in a recent note (*Die Naturwissenschaften*, July 11, 1924) communicated various important results regarding the lithium spark spectrum, obtained by the beautiful method of the hollow cathode, developed by Paschen. In addition to the line 2934 Å.U., ascribed to lithium by Mohler (*Phys. Rev.*, 23, 108, 1924), Schüler observed a number of new lines which made possible the establishment of the main features of a series scheme with fourfold Rydberg constant, which therefore was ascribed to the singly ionised lithium atom. In accordance with the theoretical expectation, that this spectrum should show a great similarity with the ordinary helium spectrum, it was also found possible in the spectrum to recognise two separate series systems. At the same time, observations of a number of lines ascribed to the lithium spark spectrum were recorded by M. Morand (*C.R.*, May 1924). The method of excitation used in his work was that of anode rays. While in our experiments only few of the lines given by Morand could be verified, most of Schüler's results were confirmed, although it seemed necessary to introduce small corrections in some of his wave-lengths, and a few modifications in the series scheme proposed. The results are stated in the following table, where the wave-lengths are given with an average accuracy of about 0·4 Å.U. The numbers in brackets are the estimated intensities.

TABLE I.

5485·5	(6)	$2s$-$2p$	3200·4	(½)	$3D$-$5F$
4881·5	(1½)	$3p$-$4s$	3196·5	(1)	$3d$-$5f$
4678·1	(1)	$3D$-$4F$	3155·4	(1)	$3p$-$5s$
4672·0	(3)	$3d$-$4f$	3034	(½)	$3P$-$5D$?
4347	(½)	$3P$-$4D$?	3029·7	(½)	$3p$-$5d$
4325·7	(2)	$3p$-$4d$	2934·2	(3)	$2S$-$2P$?
3685·0	(1)	$3s$-$4p$	2729·9	(½)	$3D$-$6F$
3285·8	(1)	$3S$-$4P$?	2728·9	(1)	$3d$-$6f$
			2612	(½)	$3P$-$6D$?

Following Schüler, a term notation analogous to that of the helium spectrum is used, the terms denoted by small letters being assumed to correspond with the helium terms of the doublet series, while the terms denoted by capital letters are assumed to correspond with the helium singlet system. While most of the lines were rather faint compared with the arc-lines, the line 5485·5 was comparatively bright, and appeared, when observed visually, with about the same intensity as the red and yellow lines of the lithium arc spectrum. This line was originally ascribed by Schüler to the presumed singlet spectrum, but from a more recent observation, kindly communicated to this Institute by Prof. Paschen, that the line in question when observed with high dispersion exhibits a complex structure, Schüler has later concluded that it must belong to the doublet spectrum. This conclusion is also in conformity with our measurements. Not only does it seem impossible in any other way to account for its intensity relative to the other observed lines, but also the absolute value of the wave-length is in complete agreement

with what should be expected from the series relation given in Table I. In fact, this leads to the following scheme of the terms of the doublet spectrum.

TABLE II.

$2s = 134{,}056$ ($n^* = 1{\cdot}81$)	$2p = 115{,}831$ ($n^* = 1{\cdot}95$)	$3d = 48{,}828$ ($n^* = 3{\cdot}00$)	$4f = 27{,}430$ ($n^* = 4{\cdot}00$)	
$3s = 55{,}308$ ($n^* = 2{\cdot}82$)	$3p = 50{,}566$ ($n^* = 2{\cdot}95$)	$4d = 27{,}455$ ($n^* = 4{\cdot}00$)	$5f = 17{,}552$ ($n^* = 5{\cdot}00$)	
$4s = 30{,}086$ ($n^* = 3{\cdot}82$)	$4p = 28{,}180$ ($n^* = 3{\cdot}95$)	$5d = 17{,}569$ ($n^* = 5{\cdot}00$)	$6f = 12{,}193$ ($n^* = 6{\cdot}00$)	
$5s = 18{,}883$ ($n^* = 4{\cdot}82$)	...	...	...	

The numbers in the brackets are the effective quantum numbers of the various terms. It will be seen that these numbers exhibit a great similarity with those of the helium-doublet spectrum, although the differences from the corresponding hydrogen values are slightly smaller in the case of the lithium spark spectrum, as should also be expected from general theoretical considerations. On account of the smaller number of the observed singlet terms and the great uncertainty attached to their series arrangement, we have confined ourselves to giving in Table I. a preliminary series notation.

In addition to the spark spectrum of lithium, the arc spectrum (lithium I-spectrum) was very strongly excited. The sharp and the diffuse series were observed up to the 10th and the 14th member, respectively.

No attempt was made to determine the minimum excitation potentials of the spark spectrum lines, but it was observed that between 150 and 200 volts accelerating potential, the intensity of the line 5485 Å.U. decreased very rapidly relative to the arc lines. An increase of accelerating potential from 300 volts to 1000 volts had no effect on the relative intensity of the arc and spark spectrum.

In addition to this method of excitation by means of impacting electrons, the lithium spark lines were also obtained under somewhat different conditions. If the vapour pressure was high and the potential between the crucible and the anode was more than 500 volts, then under the electron bombardment an arc would strike between the crucible and anode, and this arc would continue even after the electron current was cut off. This arc, in which the potential drop was 400-500 volts, and the current 400-500 ma, showed a brilliant luminescence and exhibited besides the ordinary arc lines also the spark lines, especially the line 5485 Å.U., with considerable intensity. However, excited in this way, the relative intensity of the spark spectrum compared with the arc spectrum is much smaller than when the spectra were excited by means of electron bombardment. The work will be continued.

The writer wishes to express his thanks to Dr. J. A. Christiansen, in collaboration with whom the first apparatus was designed, but who was prevented from taking part in the further developing of the work.

SVEN WERNER.
Universitetets Institut for teoretisk Fysik,
Copenhagen, January 6.

Rainfall Correlations in Trinidad.

AN important feature of modern economic geography is the study of the relationship between climatic conditions and industry. Regarding climate and weather as being respectively the static and dynamic aspects of meteorological conditions, we have in the tropics, as Dr. Martin Leake has recently emphasised, climate a determinate factor in the location of industries and colonies of people ; weather, on the other hand, is frequently the most important factor underlying local industrial *variation*. In the tropics, rainfall is generally the chief weather factor affecting crop yields, and in Trinidad (West Indies) the writer has given some attention to the relationship between variation in rainfall and yield of cacao—the island's principal product. This work has definitely established the fact that the annual variations in yield, which may deviate as much as −101·8 per cent. of a 5-year moving average (River Estate, 1921–22), are fundamentally due to variations in rainfall, though the exact extent of the connexion has not been statistically determined in all cases.

The procedure followed in the investigation was to obtain monthly rainfall and monthly crop-yield records for as many years back as possible (generally not more than 15) from the most reliable individual estates, and to work on the data for each estate separately. Finally, the annual output of cacao for the whole island was considered in relation to the average annual rainfall for all cacao districts. On the whole, I am satisfied that the data obtained are sufficiently trustworthy for the purpose of affording general indications.

It will be well to emphasise, however, that studies like the present one cannot be regarded as purely statistical : we are dealing, not with the rainfall itself but with its ultimate effects, and it is necessary to have at least an elementary knowledge of the physiological nature and habits of the cacao tree (in this particular study) in order to anticipate lags and to deal intelligently in general with the data. There is also the question of increasing or declining output as affected by agricultural management. The latter difficulty is partly overcome by plotting the yield deviations from moving averages for, say, 5-year periods. In general the "dot chart" method of plotting yield against rainfall to indicate linear correlation was employed, and in cases where the points clustered adequately, the coefficient of correlation was computed. In all cases the percentage deviations from the averages were plotted as well, in order to compare the magnitude of the variations on the same scale. It is not possible in this short note to reproduce the graphs and all the computations, but they are available for reference. The following table gives the general conclusions arrived at :

Estate.	Geographical location.	Av. ann. rainfall in. (approx.)	Correlation : Yield and rain of "wet" months.	Correlation : Yield and Nov. rain.
La Vega . .	Central Range	84	Negative	None
Non Pareil .	East end of N. Range	95	Negative	Positive
Verdant Vale	Central N. Range	85	Negative	Positive
River . .	West end of N. Range	67	(Inconclusive)	(Inconclusive)
All cacao Districts	North, Central and S.E.	73 (weighted)	Positive within limits	(Undetermined)

It would appear that estates with an average annual rainfall of 80 inches and more are less adapted for cacao, other things being equal, than estates with an average annual rainfall lying between 70 and 75 inches. In the case of La Vega estate the negative correlation was found to be extremely definite, the highest and most remarkable coefficient being in respect of the May and June rainfall and the subsequent crop. This was found to be $-0{\cdot}95 \pm 0{\cdot}10$. It is necessary to mention that this computation was made under my direction but that I have not verified it. For the rainfalls of May only, however, and subsequent yields, I myself obtained a coefficient of $-0{\cdot}85 \pm 0{\cdot}15$, which is equally, if not more surprising, because it refers to one month of the year only, and that six months prior to the coming in of the crop affected.

Verdant Vale estate has a coefficient for November rain of 0·65±0·05. The apparent importance of adequate rain during November in the Northern Range of hills is interesting, and this and many other points require further study.

Generally speaking, rainfall seems to be a fundamental factor underlying the whole economic activity of Trinidad. A close connexion was found by the writer between rainfall in Port of Spain and the electric tram-car takings, and between the business done in the shops. The latter is partly due to synchronic weather changes, and partly the effect of the previous year's rainfall and crop yields affecting the purchasing power of the inhabitants.

On the principal rubber estate I found the well-known connexion between daily rainfall and the quantity of rubber tapped from the trees. The connexion here is due to purely physical reasons, rain causing the latex to flow over the bark instead of down the central channel into the cup. The influence of rainfall on sugar-cane and coconut yields was not studied, but it may be of interest to mention that considerable work on the former relationship has been done in other countries. The most important, perhaps, of this work is A. Walter's analysis of climatic factors and the cane crop in Mauritius, that of M. Kœnig in the same Colony, and the work of T. A. Tengwall and C. E. van de Zyl in Java, which has recently established a positive correlation between sugar yield per bouw and amount of rain in October and November. A very good summary of the results obtained in the United States in regard to weather factors and cotton, Indian corn (maize) and tobacco, is to be found in J. W. Smith's "Agricultural Meteorology." Most of the correlations obtained in connexion with rainfall and tropical and sub-tropical crops have been in the neighbourhood of 0·60 with probable errors indicating a fair degree of significance.

In conclusion, I should like to emphasise the importance of this work not only from the point of view of physiology and agriculture, but also from the wider point of view of economic geography. Conditions in tropical countries have, for the most part, been fully described; what is needed now is statistical analysis and co-ordination, and from a broad administrative point of view. In Trinidad the general complaint is that short cacao crops are due to drought. On many of the best and largest estates my work indicates that the trouble is the result—or partly the result—of too much rain. W. R. DUNLOP.

34 Kensington Court, W.8.

Astrophysics without Mathematics.

SIR JOSEPH HOOKER in 1869, in undertaking to review a book for a journal of science, made the following remark: "I hope that . . . will give us better analyses of books than reviews in general afford us. We have no end of reviews, but they are generally the author's views on the subject of the book to be reviewed and convey no precise information as to the books themselves. This is a crying evil." The review by "E. A. M." in NATURE of January 10 of my book, "Modern Astrophysics," is a particularly good specimen of the type of review to which Hooker very properly took exception. The reader of this review who has not seen the book will have not the remotest idea of what I have tried to do, or of the intended (E. A. M. calls the book "amorphous") structure of the book as revealed, say, by the titles of its sections and chapters. Instead of this relevant and, one would have thought, indispensable matter, he is treated to a catalogue of E. A. M.'s misapprehensions of the subject and of his differences from me in matters of opinion.

The book is condemned from the literary point of view; it is implied that it is difficult to comprehend; and a large number of "omissions" and "errors" are selected as examples of "looseness" of reasoning. With regard to the first two points, E. A. M.'s remarks, when examined, condemn themselves, and need no comment. He is entitled to his opinion, which he is unfortunate enough not to share with a single one of the critics whose qualifications to review the book are of a literary character. I wish only to remark that E. A. M. has either not read or forgotten the preface to the book, and that his statement that the reader "is conducted twice round the whole existing observational material" is untrue.

The main part of the "review" is occupied with criticisms of points of detail. E. A. M. has evidently been peering into the book in order to make a collection of all the trivial points to which he can object, and as a result he puts forward eleven points of this kind. The reader of the "review" will probably be surprised to learn that the whole of the material in the book dealing with all except one of the points criticised by E. A. M., when put together, would make up almost exactly one page. The material dealing with the remaining point occupies four and a half pages. The book contains about 475 pages.

It is clearly an abuse of a reviewer's authority to concentrate on points of this kind, even if his criticisms on those points are valid. E. A. M., however, has not even that excuse. The only criticism in which I admit he is justified is that I have omitted to describe the general method of determining cluster parallaxes. For pointing out that omission I am indebted to him. On the other matters I have written to him personally, pointing out where he has blundered. If, after reading my letter, he so wishes, I am quite prepared to discuss any or all of the points with him when, where, and in whatever reasonable manner he may choose, in public or in private. Considering the tone in which his "review" is written, it is incumbent upon him to accept this offer or to withdraw his remarks at once.

It is very unpleasant to have to reply to a review, but the misrepresentation and tone of E. A. M.'s essay leave me no alternative in the interests of the truth I have tried to present in my book.

HERBERT DINGLE.

Imperial College of Science and Technology,
January 15, 1925.

I AM sorry that my review has caused Prof. Dingle so much pain; and I must beg him to accept my assurance that purely scientific considerations were in my mind. My review contains evidence that there were portions of the book which I read with pleasure, and I take this occasion to say so explicitly. I cannot see that my criticisms were outside the province of a reviewer, but I deeply regret that they should have been expressed in language which Prof. Dingle finds discourteous.

With regard to the substance of my criticisms in the main part of the review, I should not have made them unless I were fully prepared to justify them. After carefully examining the arguments brought forward by Prof. Dingle in his personal letter to me, I am unable to withdraw any of the ten points to which he objects, but I am willingly availing myself of the opportunity of discussing them with him privately. I am unable to agree with Prof. Dingle that the points raised are trivial. They all seemed to me either to be of fundamental importance in themselves or to involve fundamental principles.

E. A. MILNE.

Trinity College, Cambridge.

The Structure of the so-called Ultraviolet Bands of Water Vapour.

THE so-called ultraviolet bands of water vapour, which must probably be attributed to the OH-molecule,[1] have been the object of an extensive study. Heurlinger [2] succeeded in arranging almost all the lines of the band λ 3064 into 12 branches which he called P_1^k, Q_1^k, R_1^k, P_2^k, Q_2^k, R_2^k ($k = 1, 2$). But it was not possible to give a theoretical interpretation of the bands, and to decide to which quantum states of the molecule the lines belong.[3] Recently, Watson [1] measured the band λ 2811 and showed that it has exactly the same structure as the band λ 3064. These measurements, combined with those of Grebe and Holtz of the band λ 3064, enable us to get a complete insight into the structure of these bands. With the aid of the combination principle it is possible to get the relative values of the rotational terms without any theoretical assumption about the structure of the molecule. The results obtained are summarised below. (Details will be published in the Proc. Roy. Acad. Amsterdam.)

(1) The six branches P_i^1, Q_i^1, R_i^1 ($i = 1, 2$) form one band which we shall denote by I, and the branches P_i^2, Q_i^2, R_i^2 another band (II), so that what is called a band consists in reality of two bands, which must be attributed to different oscillation transitions; *e.g.*

	I	II
λ 3064	$0 \rightarrow 0$	$1 \rightarrow 1$
λ 2811	$1 \rightarrow 0$	$2 \rightarrow 1$

(the transition $0 \rightarrow 0$ for λ 3064 I is chosen arbitrarily). Then λ 2811 I and λ 3064 II must have the same initial state, which is confirmed by the combination principle. That the bands λ 3064 and λ 2811 have the same final state was already pointed out by Watson.

(2) The six branches of one band must be represented by the following scheme:

$$\begin{array}{ll|ll} P_1(m) = F_1(m-1) - f_1(m) & & P_2(m) = F_2(m-1) - f_2(m) \\ Q_1(m) = F_1(m) - f_1'(m) & & Q_2(m) = F_2(m) - f_2'(m) \\ R_1(m) = F_1(m+1) - f_1(m) & , & R_2(m) = F_2(m+1) - f_2(m), \end{array}$$

which is derived from the relations—

$$\left.\begin{array}{l} Q_i(m) - P_i(m+1) \\ R_i(m) - Q_i(m+1) \end{array}\right\} \text{ are the same for } \lambda\,3064 \text{ and } \lambda\,2811$$

$$R_i(m) - P_i(m) \quad \text{are the same for } \lambda\,3064 \text{ II and } \lambda\,2811 \text{ I}$$

$$Q_i(m) - P_i(m+1) \neq R_i(m) - Q_i(m+1) \text{ in one band.}$$

(3) As is well known, the lines do not follow Deslandres's rule for small values of m. There must therefore be a component of the electronic impulse along the axis of figure as well as one perpendicular to it.[4] The terms cannot be represented by the formula of Kramers and Pauli, or by the modification of it with which Kratzer [5] succeeded in representing the terms of the (C+H) bands. This shows that the electronic impulse cannot be connected quasi-rigidly with the molecule. It seems that the electronic impulse has a precession which increases with growing m.

(4) Fortrat [6] showed that most of the lines are accompanied by satellites. It is very probable that these satellites arise from the same quantum states of the molecule as the lines themselves, which indicates that they are also combinations between the terms given above. The three satellites of Q_2 are then, for example,

$$F_1(m) - f_2'(m) \qquad F_1(m) - f_2(m) \qquad F_2(m) - f_2(m)$$

The precision of the measurements, however, does not permit of deciding this question with certainty. It is not impossible that there are other terms slightly different from the former ones which are responsible for the satellites.

G. H. DIEKE.
Instituut voor theoretische natuurkunde,
Leyden.

[1] W. W. Watson, *Astroph. Journal*, 60, p. 145 (1924).
[2] T. Heurlinger, "Untersuchungen über die Struktur der Bandenspektra," Lund, 1918.
[3] Cf. A. Sommerfeld, "Atombau und Spektrallinien," 3rd ed. p. 527.
[4] H. A. Kramers and W. Pauli, *Zeit. f. Phys.*, 13, p. 351 (1923).
[5] A. Kratzer, *Zeit. f. Phys.*, 23, p. 298 (1924).
[6] R. Fortrat, *Journal de Phys.*, 5, p. 20 (1924).

Hafnium Oxide in Tungsten Filaments.

IT has been known for a long time that perfectly pure tungsten cannot be used for the manufacture of filaments for electric lamps on account of its "off-setting" structure due to recrystallisation. It has been found also that recrystallisation can be essentially influenced by suitable additions. Thus, for example, thorium oxide or silicon oxide can be used with good results.

By mixing tungsten oxide with a solution of hafnium nitrate, evaporating the latter to dryness, heating the product obtained and reducing it then with hydrogen, tungsten powder is formed, having a definite content of hafnium oxide. In my experiments the latter was comprised between 0·1 and 3 per cent.

During the subsequent sintering operation in hydrogen to which the compressed and heated rod is submitted, a small part of the hafnium oxide is reduced, and the hafnium produced combines with the tungsten. During the subsequent swaging operation, this formation of a solid solution causes difficulties which can be easily obviated by using nitrogen or rare gases instead of hydrogen. In this case the swaging and drawing operation is readily effected.

The hafnium oxide is distinguished by its high melting-point and its low vapour pressure at high temperatures, so that it has proved to be a suitable addition to tungsten for filaments. The vapour tension at the temperature of the sintering operation is so low that no evaporation whatever of hafnium oxide could be ascertained.

J. A. M. VAN LIEMPT.
Physical Chemistry Laboratory,
Philips' Glowlamp Works, Ltd.,
Eindhoven (Holland).

Citrus Fruit and Scurvy.

IN "Purchas his Pilgrimage or Relations of the World and the Religions observed in al Ages and Places discovered" there are some interesting references to the disease scurvy. The edition I possess is the third, dated 1617; our Public Library in Melbourne having only the fourth, dated 1626.

On page 865 of this third edition the following statement occurs: "The Scorbute so weakened their men, that they were not able to hoise (*sic*) out their boats, except in the Generalls ship, whose men (drinking euery morning three spoonefuls of the iuice of Limons) were healthfull."

Again, on page 1086 there is a description of scurvy with a marginal printed note as follows: "Oranges, Limons, and the like are excellent remedies to this disease."

I regret I have not access to the first and second editions of the work, but as it is, this surely constitutes one of the earliest references to the citrus cure or prevention of scurvy.

W. A. OSBORNE.
The University of Melbourne,
December 9.

Australopithecus africanus: The Man-Ape of South Africa.

By Prof. RAYMOND A. DART, University of the Witwatersrand, Johannesburg, South Africa.

TOWARDS the close of 1924, Miss Josephine Salmons, student demonstrator of anatomy in the University of the Witwatersrand, brought to me the fossilised skull of a cercopithecid monkey which, through her instrumentality, was very generously loaned to the Department for description by its owner, Mr. E. G. Izod, of the Rand Mines Limited. I learned that this valuable fossil had been blasted out of the limestone cliff formation—at a vertical depth of 50 feet and a horizontal depth of 200 feet—at Taungs, which lies 80 miles north of Kimberley on the main line to Rhodesia, in Bechuanaland, by operatives of the Northern Lime Company. Important stratigraphical evidence has been forthcoming recently from this district concerning the succession of stone ages in South Africa (Neville Jones, Jour. Roy. Anthrop. Inst., 1920), and the feeling was entertained that this lime deposit, like that of Broken Hill in Rhodesia, might contain fossil remains of primitive man.

I immediately consulted Dr. R. B. Young, professor of geology in the University of the Witwatersrand, about the discovery, and he, by a fortunate coincidence, was called down to Taungs almost synchronously to investigate geologically the lime deposits of an adjacent farm. During his visit to Taungs, Prof. Young was enabled, through the courtesy of Mr. A. F. Campbell, general manager of the Northern Lime Company, to inspect the site of the discovery and to select further samples of fossil material for me from the same formation. These included a natural cercopithecid endocranial cast, a second and larger cast, and some rock fragments disclosing portions of bone. Finally, Dr. Gordon D. Laing, senior lecturer in anatomy, obtained news, through his friend Mr. Ridley Hendry, of another primate skull from the same cliff. This cercopithecid skull, the possession of Mr. De Wet, of the Langlaagte Deep Mine, has also been liberally entrusted by him to the Department for scientific investigation.

FIG. 1.—Norma facialis of *Australopithecus africanus* aligned on the Frankfort horizontal.

The cercopithecid remains placed at our disposal certainly represent more than one species of catarrhine ape. The discovery of Cercopithecidæ in this area is not novel, for I have been informed that Mr. S. Haughton has in the press a paper discussing at least one species of baboon from this same spot (Royal Society of South Africa). It is of importance that, outside of the famous Fayüm area, primate deposits have been found on the African mainland at Oldaway (Hans Reck, *Sitzungsbericht der Gesellsch. Naturforsch. Freunde*, 1914), on the shores of Victoria Nyanza (C. W. Andrews, *Ann. Mag. Nat. Hist.*, 1916), and in Bechuanaland, for these discoveries lend promise to the expectation that a tolerably complete story of higher primate evolution in Africa will yet be wrested from our rocks.

In manipulating the pieces of rock brought back by Prof. Young, I found that the larger natural endocranial cast articulated exactly by its fractured frontal extremity with another piece of rock in which the broken lower and posterior margin of the left side of a mandible was visible. After cleaning the rock mass, the outline of the hinder and lower part of the facial skeleton came into view. Careful development of the solid limestone in which it was embedded finally revealed the almost entire face depicted in the accompanying photographs.

It was apparent when the larger endocranial cast was first observed that it was specially important, for its size and sulcal pattern revealed sufficient similarity with those of the chimpanzee and gorilla to demonstrate that one was handling in this instance an anthropoid and not a cercopithecid ape. Fossil anthropoids have not hitherto been recorded south of the Fayüm in Egypt, and living anthropoids have not been discovered in recent times south of Lake Kivu region in Belgian Congo, nearly 2000 miles to the north, as the crow flies.

All fossil anthropoids found hitherto have been known only from mandibular or maxillary fragments, so far as crania are concerned, and so the general appearance of the types they represented has been unknown; consequently, a condition of affairs where virtually the whole face and lower jaw, replete with teeth, together with the major portion of the brain pattern, have been preserved, constitutes a specimen of unusual value in fossil anthropoid discovery. Here, as in *Homo rhodesiensis*, Southern Africa has provided documents of higher primate evolution that are amongst the most complete extant.

Apart from this evidential completeness, the specimen is of importance because it exhibits an extinct race of apes *intermediate between living anthropoids and man*.

In the first place, the whole cranium displays *humanoid* rather than anthropoid lineaments. It is markedly dolichocephalic and leptoprosopic, and manifests in a striking degree the *harmonious relation* of calvaria to face emphasised by Pruner-Bey. As Topinard says, "A cranium elongated from before backwards, and at the same time elevated, is already in harmony by itself; but if the face, on the other hand, is elongated from above downwards, and narrows, the harmony is complete." I have assessed roughly the difference in the relationship of the glabella-gnathion facial length to the glabella-inion calvarial length in recent African anthropoids of an age comparable with that of this specimen (depicted in Duckworth's "Anthropology and Morphology," second edition, vol. i.), and find that, if the glabella-inion length be regarded in all three as 100, then the glabella-gnathion length in the young chimpanzee is approximately 88, in the young gorilla 80, and in this fossil 70, which proportion suitably demonstrates the enhanced

relationship of cerebral length to facial length in the fossil (Fig. 2).

The glabella is tolerably pronounced, but any traces of the salient supra-orbital ridges, which are present even in immature living anthropoids, are here entirely absent. Thus the relatively increased glabella-inion measurement is due to brain and not to bone. Allowing 4 mm. for the bone thickness in the inion region, that measurement in the fossil is 127 mm.; *i.e.* 4 mm. less than the same measurement in an adult chimpanzee in the Anatomy Museum at the University of the Witwatersrand. The orbits are not in any sense detached from the forehead, which rises steadily from their margins in a fashion amazingly human. The interorbital width is very small (13 mm.) and the ethmoids are not blown out laterally as in modern African anthropoids. This lack of ethmoidal expansion causes the lacrimal fossæ to face posteriorly and to lie relatively far back in the orbits, as in man. The orbits, instead of being subquadrate as in anthropoids, are almost circular, furnishing an orbital index of 100, which is well within the range of human variation (Topinard, "Anthropology"). The malars, zygomatic arches, maxillæ, and mandible all betray a delicate and humanoid character. The facial prognathism is relatively slight, the gnathic index of Flower giving a value of 109, which is scarcely greater than that of certain Bushmen (Strandloopers) examined by Shrubsall. The nasal bones are not prolonged below the level of the lower orbital margins, as in anthropoids, but end above these, as in man, and are incompletely fused together in their lower half. Their maximum length (17 mm.) is not so great as that of the nasals in *Eoanthropus dawsoni*. They are depressed in the median line, as in the chimpanzee, in their lower half, but it seems probable that this depression has occurred post-mortem, for the upper half of each bone is arched forwards (Fig. 1). The nasal aperture is small and is just wider than it is high (17 mm. × 16 mm.). There is no nasal spine, the floor of the nasal cavity being continuous with the anterior aspect of the alveolar portions of the maxillæ, after the fashion of the chimpanzee and of certain New Caledonians and negroes (Topinard, *loc. cit.*).

In the second place, the dentition is *humanoid* rather than anthropoid. The specimen is juvenile, for the

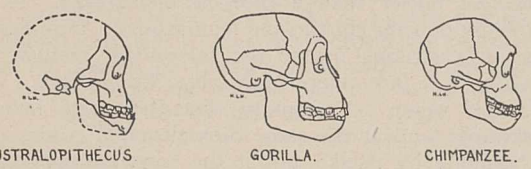

FIG. 2.—Cranial form in living anthropoids of similar age (after Duckworth) and in the new fossil. For this comparison, the fossil is regarded as having the same calvarial length as the gorilla.

first permanent molar tooth only has erupted in both jaws on both sides of the face; *i.e.* it corresponds anatomically with a human child of six years of age. Observations upon the milk dentition of living primates are few, and only one molar tooth of the deciduous dentition in one fossil anthropoid is known (Gregory, "The Origin and Evolution of the Human Dentition," 1920). Hence the data for the necessary comparisons are meagre, but certain striking features of the milk dentition of this creature may be mentioned. The tips of the canine teeth transgress very slightly (0·5-0·75 mm.) the general margin of the teeth in each jaw, *i.e.* very little more than does the human milk canine. There is no diastema whatever between the premolars and canines on either side of the lower jaw, such as is present in the deciduous dentition of living anthropoids; but the canines in this jaw come, as in the human jaw, into alignment with the incisors (Gregory, *loc. cit.*). There is a diastema (2 mm. on the right side, and 3 mm. on the left side) between the canines and lateral incisors of the upper jaw; but seeing, first, that the incisors are narrow, and, secondly, that diastemata (1 mm.-1·5 mm.) occur between the central incisors of the upper jaw and between the medial and lateral incisors of both sides in the lower jaw, and, thirdly, that some separation of the milk teeth takes place even in mankind (Tomes, "Dental Anatomy," seventh edition) during the establishment of the permanent dentition, it is evident that the diastemata which occur in the upper jaw are small. The lower canines, nevertheless, show wearing facets both for the upper canines and for the upper lateral incisors.

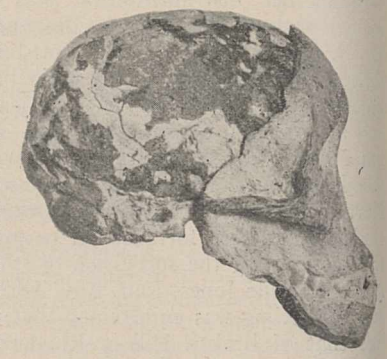

FIG. 3.—Norma lateralis of *Australopithecus africanus* aligned on the Frankfort horizontal.

The incisors as a group are irregular in size, tend to overlap one another, and are almost vertical, as in man; they are not symmetrical and well spaced, and do not project forwards markedly, as in anthropoids. The upper lateral incisors do project forwards to some extent and perhaps also do the upper central incisors very slightly, but the lateral lower incisors betray no evidence of forward projection, and the central lower incisors are not even vertical as in most races of mankind, but are directed slightly backwards, as *sometimes* occurs in man. Owing to these remarkably human characters displayed by the deciduous dentition, when contour tracings of the upper jaw are made, it is found that the jaw and the teeth, as a whole, take up a parabolic arrangement comparable only with that presented by mankind amongst the higher primates. These facts, together with the more minute anatomy of the teeth, will be illustrated and discussed in the memoir which is in the process of elaboration concerning the fossil remains.

In the third place, the mandible itself is *humanoid* rather than anthropoid. Its ramus is, on the whole, short and slender as compared with that of anthropoids, but the bone itself is more massive than that of a human being of the same age. Its symphyseal region is virtually complete and reveals anteriorly a more vertical outline than is found in anthropoids or even in the jaw of Piltdown man. The anterior symphyseal surface is scarcely less vertical than that of Heidelberg man. The posterior symphyseal surface in living

anthropoids differs from that of modern man in possessing a pronounced posterior prolongation of the lower border, which joins together the two halves of the mandible, and so forms the well-known *simian shelf* and above it a deep genial impression for the attachment of the tongue musculature. In this character, *Eoanthropus dawsoni* scarcely differs from the anthropoids, especially the chimpanzee; but this new fossil betrays no evidence of such a shelf, the lower border of the mandible having been massive and rounded after the fashion of the mandible of *Homo heidelbergensis*.

FIG. 4.—Norma basalis of *Australopithecus africanus* aligned on the Frankfort horizontal.

That hominid characters were not restricted to the face in this extinct primate group is borne out by the relatively forward situation of the foramen magnum. The position of the basion can be assessed within a few millimetres of error, because a portion of the right exoccipital is present alongside the cast of the basal aspect of the cerebellum. Its position is such that the basi-prosthion measurement is 89 mm., while the basi-inion measurement is at least 54 mm. This relationship may be expressed in the form of a "head-balancing" index of 60·7. The same index in a baboon provides a value of 41·3, in an adult chimpanzee 50·7, in Rhodesian man 83·7, in a dolichocephalic European 90·9, and in a brachycephalic European 105·8. It is significant that this index, which indicates in a measure the poise of the skull upon the vertebral column, points to the assumption by this fossil group of an attitude appreciably more erect than that of modern anthropoids. The improved poise of the head, and the better posture of the whole body framework which accompanied this alteration in the angle at which its dominant member was supported, is of great significance. It means that a greater reliance was being placed by this group upon the feet as organs of progression, and that the hands were being freed from their more primitive function of accessory organs of locomotion. Bipedal animals, their hands were assuming a higher evolutionary rôle not only as delicate tactual, examining organs which were adding copiously to the animal's knowledge of its physical environment, but also as instruments of the growing intelligence in carrying out more elaborate, purposeful, and skilled movements, and as organs of offence and defence. The latter is rendered the more probable, in view, first, of their failure to develop massive canines and hideous features, and, secondly, of the fact that even living baboons and anthropoid apes can and do use sticks and stones as implements and as weapons of offence ("Descent of Man," p. 81 *et seq.*).

Lastly, there remains a consideration of the endocranial cast which was responsible for the discovery of the face. The cast comprises the right cerebral and cerebellar hemispheres (both of which fortunately meet the median line throughout their entire dorsal length) and the anterior portion of the left cerebral hemisphere. The remainder of the cranial cavity seems to have been empty, for the left face of the cast is clothed with a picturesque lime crystal deposit; the vacuity in the left half of the cranial cavity was probably responsible for the fragmentation of the specimen during the blasting. The cranial capacity of the specimen may best be appreciated by the statement that the length of the cavity could not have been less than 114 mm., which is 3 mm. greater than that of an adult chimpanzee in the Museum of the Anatomy Department in the University of the Witwatersrand, and only 14 mm. less than the greatest length of the cast of the endocranium of a gorilla chosen for casting on account of its great size. Few data are available concerning the expansion of brain matter which takes place in the living anthropoid brain between the time of eruption of the first permanent molars and the time of their becoming adult. So far as man is concerned, Owen ("Anatomy of Vertebrates," vol. iii.) tells us that "The brain has advanced to near its term of size at about ten years, but it does not usually obtain its full development till between twenty and thirty years of age." R. Boyd (1860) discovered an increase in weight of nearly 250 grams in the brains of male human beings after they had reached the age of seven years. It is therefore reasonable to believe that the adult forms typified by our present specimen possessed brains which were larger than that of this juvenile specimen, and equalled, if they did not actually supersede, that of the gorilla in absolute size.

Whatever the total dimensions of the adult brain may have been, there are not lacking evidences that the brain in this group of fossil forms was distinctive in type and was an instrument of greater intelligence that that of living anthropoids. The face of the endocranial cast is scarred unfortunately in several places (cross-hatched in the dioptographic tracing—see Fig. 5). It is evident that the relative proportion

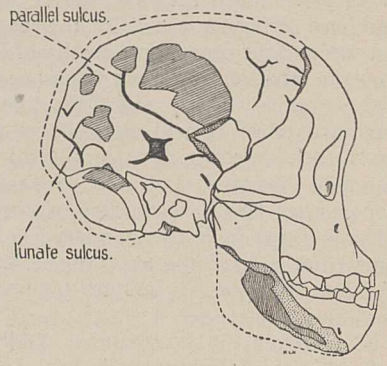

FIG. 5.—Dioptographic tracing of *Australopithecus africanus* (right side), $\times \frac{1}{3}$.

of cerebral to cerebellar matter in this brain was greater than in the gorilla's. The brain does not show that general pre- and post-Rolandic flattening characteristic of the living anthropoids, but presents a rounded and well-filled-out contour, which points to a symmetrical and balanced development of the faculties of associative memory and intelligent activity. The pithecoid type of parallel sulcus is preserved, but the sulcus lunatus has been thrust backwards towards the occipital pole by a pronounced general

bulging of the parieto-temporo-occipital association areas.

To emphasise this matter, I have reproduced (Fig. 6) superimposed coronal contour tracings taken at the widest part of the parietal region in the gorilla endocranial cast and in this fossil. Nothing could illustrate better the mental gap that exists between living anthropoid apes and the group of creatures which the fossil represents than the flattened atrophic appearance of the parietal region of the brain (which lies between the visual field on one hand, and the tactile and auditory fields on the other) in the former and its surgent vertical and dorso-lateral expansion in the latter. The expansion in this area of the brain is the more significant in that it explains the posterior *humanoid* situation of the sulcus lunatus. It indicates (together with the narrow interorbital interval and human characters of the orbit) the fact that this group of beings, having acquired the faculty of stereoscopic vision, had profited beyond living anthropoids by setting aside a relatively much larger area of the cerebral cortex to

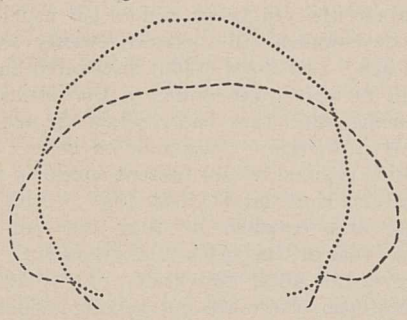

FIG. 6.—Contour tracings of coronal sections through the widest part of the parietal region of the endocranial casts in Australopithecus ..... and in a gorilla - - - -.

serve as a storehouse of information concerning their objective environment as its details were simultaneously revealed to the senses of vision and touch, and also of hearing. They possessed to a degree unappreciated by living anthropoids the use of their hands and ears and the consequent faculty of associating with the colour, form, and general appearance of objects, their weight, texture, resilience, and flexibility, as well as the significance of sounds emitted by them. In other words, their eyes saw, their ears heard, and their hands handled objects with greater meaning and to fuller purpose than the corresponding organs in recent apes. They had laid down the foundations of that discriminative knowledge of the appearance, feeling, and sound of things that was a necessary milestone in the acquisition of articulate speech.

There is, therefore, an ultra-simian quality of the brain depicted in this immature endocranial cast which harmonises with the ultra-simian features revealed by the entire cranial topography and corroborates the various inferences drawn therefrom. The two thousand miles of territory which separate this creature from its nearest living anthropoid cousins is indirect testimony to its increased intelligence and mastery of its environment. It is manifest that we are in the presence here of a pre-human stock, neither chimpanzee nor gorilla, which possesses a series of differential characters not encountered hitherto in any anthropoid stock. This complex of characters exhibited is such that it cannot be interpreted as belonging to a form ancestral to any living anthropoid. For this reason, we may be equally confident that there can be no question here of a primitive anthropoid stock such as has been recovered from the Egyptian Fayüm. Fossil anthropoids, varieties of Dryopithecus, have been retrieved in many parts of Europe, Northern Africa, and Northern India, but the present specimen, despite its youth, cannot be confused with anthropoids having the dryopithecid dentition. Other fossil anthropoids from the Siwalik hills in India (Miocene and Pliocene) are known which, according to certain observers, may be ancestral to modern anthropoids and even to man.

Whether our present fossil is to be correlated with the discoveries made in India is not yet apparent; that question can only be solved by a careful comparison of the permanent molar teeth from both localities. It is obvious, meanwhile, that it represents a fossil group distinctly advanced beyond living anthropoids in those two dominantly human characters of facial and dental recession on one hand, and improved quality of the brain on the other. Unlike Pithecanthropus, it does not represent an ape-like man, a caricature of precocious hominid failure, but a creature well advanced beyond modern anthropoids in just those characters, facial and cerebral, which are to be anticipated in an extinct link between man and his simian ancestor. At the same time, it is equally evident that a creature with anthropoid brain capacity, and lacking the distinctive, localised temporal expansions which appear to be concomitant with and necessary to articulate man, is no true man. It is therefore logically regarded as a man-like ape. I propose tentatively, then, that a new family of *Homo-simiadæ* be created for the reception of the group of individuals which it represents, and that the first known species of the group be designated *Australopithecus africanus*, in commemoration, first, of the extreme southern and unexpected horizon of its discovery, and secondly, of the continent in which so many new and important discoveries connected with the early history of man have recently been made, thus vindicating the Darwinian claim that Africa would prove to be the cradle of mankind.

It will appear to many a remarkable fact that an ultra-simian and pre-human stock should be discovered, in the first place, at this extreme southern point in Africa, and, secondly, in Bechuanaland, for one does not associate with the present climatic conditions obtaining on the eastern fringe of the Kalahari desert an environment favourable to higher primate life. It is generally believed by geologists (*vide* A. W. Rogers, "Post-Cretaceous Climates of South Africa," *South African Journal of Science*, vol. xix., 1922) that the climate has fluctuated within exceedingly narrow limits in this country since Cretaceous times. We must therefore conclude that it was only the enhanced cerebral powers possessed by this group which made their existence possible in this untoward environment.

In anticipating the discovery of the true links between the apes and man in tropical countries, there has been a tendency to overlook the fact that, in the luxuriant forests of the tropical belts, Nature was supplying with profligate and lavish hand an easy and sluggish solution, by adaptive specialisation, of the

problem of existence in creatures so well equipped mentally as living anthropoids are. For the production of man a different apprenticeship was needed to sharpen the wits and quicken the higher manifestations of intellect—a more open veldt country where competition was keener between swiftness and stealth, and where adroitness of thinking and movement played a preponderating rôle in the preservation of the species. Darwin has said, "no country in the world abounds in a greater degree with dangerous beasts than Southern Africa," and, in my opinion, Southern Africa, by providing a vast open country with occasional wooded belts and a relative scarcity of water, together with a fierce and bitter mammalian competition, furnished a laboratory such as was essential to this penultimate phase of human evolution.

In Southern Africa, where climatic conditions appear to have fluctuated little since Cretaceous times, and where ample dolomitic formations have provided innumerable refuges during life, and burial-places after death, for our troglodytic forefathers, we may confidently anticipate many complementary discoveries concerning this period in our evolution.

In conclusion, I desire to place on record my indebtedness to Miss Salmons, Prof. Young, and Mr. Campbell, without whose aid the discovery would not have been made; to Mr. Len Richardson for providing the photographs; to Dr. Laing and my laboratory staff for their willing assistance; and particularly to Mr. H. Le Helloco, student demonstrator in the Anatomy Department, who has prepared the illustrations for this preliminary statement.

Biographical Byways.[1]

By Sir ARTHUR SCHUSTER, F.R.S.

6. S. P. LANGLEY (1831–1906).

LANGLEY'S invention of the bolometer, and his pioneer work in the construction of the flying machine, are achievements sufficiently great to ensure a reputation which will outweigh the recollection of defects due to an exaggerated consciousness of dignity, accompanied by a marked inability to see the humorous side of things. I first met Langley on the occasion of the total solar eclipse in August 1878, when he established an observing station on the top of Pike's Peak in order to obtain, if possible, a measure of the thermal radiation of the solar corona. Unfortunately, he suffered severely from mountain sickness, and had to be carried down before the day of the eclipse.

In the following year, Langley visited England and expressed to me the desire to become acquainted with Clerk Maxwell. I was working at the Cavendish Laboratory at the time, and was able to assure him that Maxwell would be interested to meet him as he had, in my presence, referred in very eulogistic terms to a method proposed by Langley to eliminate the personal equation in transit observations. Clerk Maxwell was just then editing Cavendish's scientific manuscripts, and conscientiously repeated every experiment that was described in them. He was specially interested in the method which Cavendish had devised for estimating the relative intensities of two electric currents, by sending the currents through his body and comparing the muscular contraction felt on interrupting the currents: "Every man his own galvanometer," as Maxwell expressed it. When Langley arrived, I took him to the room where Maxwell stood in his shirt sleeves with each hand in a basin filled with water through which the current was laid. Enthusiastic about the unexpected accuracy of the experiment, and assuming that every scientific man was equally interested, he tried to persuade Langley to take off his coat and have a try. This was too much for Langley's dignity; he did not even make an effort to conceal his anger, and on leaving the laboratory he turned round and said to me: "When an English man of science comes to the United States we do not treat him like that." I explained that, had he only had a little patience and entered into the spirit of Maxwell's experiment, the outcome of his visit would have been more satisfactory.

As an experimenter Langley takes a high rank, though the numerical results he derived were sometimes based on calculations that were not entirely free from defects. This led him occasionally to an optimistic judgment of their accuracy. In sending out an assistant to repeat his measurement of the so-called solar constant, which expresses the total solar radiation in certain units, his final words to him were: "Remember that the nearer your result approaches the number 3, the higher will be my opinion of the accuracy of your observations." The assistant, who since then has himself attained a high position among American men of science, fortunately was a man of independent judgment and skilful both in taking and reducing his observations, with the result that the number 3 is now altogether discredited.

[1] Continued from p. 163.

Obituary.

DR. J. M. ELLIS MCTAGGART.

THE news of the sudden death of Dr. McTaggart on January 18, at the early age of fifty-eight, came as a great shock to his numerous colleagues and friends both in Cambridge and throughout Great Britain. He had, indeed, resigned his lectureship in Trinity College, Cambridge, more than a year ago in order to devote more time to literary work; but he went on giving some of the courses of lectures he had been accustomed to give, and his interest in everything that pertained to the University continued to be as keen as ever. His Friday evening lectures, open to students of all schools, have been for many years past a Cambridge institution; and various stories are related of his acuteness, resource, and ready wit in endeavouring to initiate the *profanum vulgus* in the problems of metaphysics. In the affairs of his College and in those of the University he took a leading and conspicuous part, bringing to bear upon every issue a fearless independence of judgment, which won for him the

respect and esteem even of those to whom he was most opposed in opinion. In politics he was strongly conservative, although here again he never allowed himself to be fettered by party ties but pursued a path distinctly his own.

McTaggart was a born metaphysician. Even as a promising and favourite pupil of J. M. Wilson at Clifton, he is said to have displayed dialectical skill; and, on entering Trinity College, Cambridge, he began a brilliant career as an undergraduate, taking his degree as alone in the first class in the Moral Sciences Tripos of 1888. In 1891 he was elected a fellow of Trinity, having submitted as a dissertation the substance of what now forms the first four chapters of the book he published in 1896 (dedicated "to Miss Frances Power Cobbe, with much gratitude"), entitled "Studies in Hegelian Dialectic." There followed in 1901 "Studies in Hegelian Cosmology." An early draft of the last chapter on "The Further Determination of the Absolute" had been previously printed, in 1894, for "private circulation only"; and in the preface to this pamphlet the author characteristically observed: "I hoped that an attempt to explain my position to a few of my teachers and fellow-students might produce criticisms or refutations which should be profitable either in improving or preventing any further work on my part." Still another book on Hegel—"A Commentary on Hegel's Logic"—appeared in 1910. Here we are told that Hegel had been the chief object of McTaggart's life for twenty-one years, and he expresses his conviction that Hegel had penetrated further into the true nature of reality than any philosopher either before or after him. A more popular work, "Some Dogmas of Religion," saw the light in 1906; in it many novel views were propounded and they elicited no small amount of discussion. Lastly, in 1921, McTaggart published the first volume of what was evidently intended to be his *magnum opus*, on "The Nature of Existence." It is understood that he has left the manuscript of the remaining volume in a condition that will enable it to be put into print, so that we shall fortunately not be deprived of the outcome of his maturest reflection.

To indicate the distinctive features of McTaggart's speculation in a few words is scarcely possible. In the "Commentary" mentioned above he stated his belief that the next task of philosophy will be to make a fresh investigation of the nature of reality "by a dialectic method substantially, though not entirely, the same as Hegel's"; and, in his last book, he attempted to show how that task is to be fulfilled. His method differs from Hegel's principally in neither accepting a *triadic* division of categories nor the partial falsehood of the lower categories. In the first part of his system, that dealing with the general nature of the existent, he admitted only two empirical premises—that "something exists" and that "what exists is differentiated"—and the rest, he claimed, is entirely *a priori*; in the second part, the results obtained in the first part were to be applied to the facts which empirical observation reveals, or appears to reveal.

McTaggart's idealism was not of the epistemological type; it did not rest, that is to say, upon any assumed dependence of the object known upon the knowing subject; it was what he was in the habit of calling ontological idealism, as based upon the ground that nothing exists but spirit. Spirituality he defined as the quality of having content, such content being the content of one or more selves; and he held that the only existent realities are selves, groups of selves, and parts of selves. Among these selves there might conceivably be one self whose volitions had the appearance of influencing the rest of the universe so profoundly that he would properly be called a god; but McTaggart could find no evidence which would make his existence probable. Indeed, if the universe consist of a system of selves, and if that system be a unity which possesses spiritual significance and value, there would be, he urged, no need of a directing mind to account for the traces of order in it. In any case, if the universe be a society of selves, it cannot *be* a self; and, therefore, the *Absolute* cannot be God. Time, according to McTaggart, is an appearance which will ultimately merge into the timeless or the eternal. Finite selves will go on existing after death until they reach the end of the time series. They cannot be said to be immortal in the ordinary sense, but their lives will not really end, although their unendingness cannot be an unending duration in time.

G. DAWES HICKS.

MR. C. H. WORDINGHAM.

MR. CHARLES HENRY WORDINGHAM, who died on January 28 at the age of fifty-eight years, was well known as an electrical engineer. He was born at Twickenham in 1866, and was educated at King's College School and at King's College, London. He served his apprenticeship under Dr. John Hopkinson. He then joined the United Telephone Company, where his work consisted mainly in assisting with the erection of telephone exchanges. From 1889 to 1892 he was an engineer at the Grosvenor Gallery Generating Station of the London Electric Supply Corporation, where he was associated with Dr. Ferranti and Mr. Partridge in carrying out many of the pioneering experiments which led the way to such important developments. During this period also he was head of the meter testing department and devised methods of testing switches and fuses which were very useful in practical work. In 1892 he again became an assistant to Dr. Hopkinson and supervised the erection of the electric lighting stations at Manchester and Whitehaven. In 1894 he became chief engineer to the electricity works of the Manchester Corporation, and for the next seven years devoted himself whole-heartedly to developing the station.

In these early days many installations were laid down most carelessly, and the material employed was unsuitable. Wordingham established a testing department at the works and insisted that all the switches, fuses and other material used by his consumers should pass a standard test. He encountered great opposition at the start, but ultimately the manufacturers saw that it was to their advantage to have their devices tested. During his stay in Manchester he superintended the conversion of some 100 miles of tramways from horse to electric traction, and equipped 38 miles of new tramway.

Wordingham left Manchester in 1901 to practise as a

consulting engineer, and in 1903 he was offered and accepted the post of electrical engineer-in-chief to the Admiralty. Here he was responsible for the electrical equipment of all his Majesty's ships and for the electrical lighting and power used in the dockyards, including Rosyth and all the naval air stations. In 1918 he left the Navy and resumed his consulting practice. He was consulted by many local authorities on traction and lighting projects. He also gave expert evidence and supervised the erection of several power stations.

Wordingham served for many years on the council of the Institution of Electrical Engineers and no one took a greater interest in practically all the committees. He was president of the Institution in 1917 and 1918, and laid down a standard of work which subsequent presidents have found it difficult to equal. He was very enthusiastic that the Institution should found a Proving House for all electrical apparatus and material, but many difficulties stood in the way. During his presidentship he helped to found the Society of Radiographers, which is doing useful work. He made many contributions to the technical journals and wrote a useful book on "Central Electrical Stations."

He was president of the Junior Institution of Engineers and always took the greatest interest in young engineers, doing his utmost to encourage them.

A vast amount of work was also done by Wordingham in connexion with the Engineering Standards Association, being chairman of the Electrical Sectional Committees. He also took endless pains in getting the Wiring Rules of the Institution of Electrical Engineers accepted by the authorities. He has died at a comparatively early age, leaving many of the projects in which he was enthusiastically interested half finished. He was very popular with his colleagues, and he will be grievously missed by every electrical engineer.

A. R.

Mr. George Abbott.

GEOLOGY perhaps more than any other science needs all the assistance which careful amateurs can bring to the total sum of knowledge. Men living on the spot are of the greatest service to the official geologists when a re-survey takes place. George Abbott was one of the most painstaking of local geologists, whose help was always at the service of those who needed it. Born on March 25, 1844, he was in his eighty-first year when he died on January 12 at Tunbridge Wells, where he had lived since 1878. Scattered in various publications are many of his contributions to geology, but he was particularly interested in the various rock-forms which so often resemble organised life. From the magnesian limestone of Fulwell he obtained most of his specimens, and these he classified in so clear a manner that one was able to realise from his tables the series of stages by which such forms gradually grew to their familiar pseudo-organic shapes.

In 1896, in conjunction with the Rev. T. R. R. Stebbing, Abbott conceived the happy thought of creating a union of scientific and similar societies in the south-east of England for mutual help, and the first two of the South-Eastern Union's Annual Congresses were held at Tunbridge Wells. The Union grew into a vigorous organisation and has held its annual congresses regularly ever since, whilst its annual proceedings, *The South-Eastern Naturalist*, is now accepted as a responsible scientific publication. Some years later he founded a Geological Physics Society, but here apparently was a society which was not needed, for after a few years of vicissitude it ceased to exist. Its work is being done by other organisations, but as a protest against the overpowering study of palæontology it performed some useful work.

Abbott had suffered a good deal during the last few years, and his favourite study, apart from his medical duties, was a great comfort in the time that he was laid by. He founded the local natural history society, and supplied many specimens to the elementary schools of the borough, on the Town Council of which he served for some years. He also established the Eye and Ear Hospital at Tunbridge Wells, and was Hon. Surgeon from 1878 to 1886.

WE regret to announce the following deaths:

Prof. W. A. Haswell, F.R.S., emeritus professor of biology in the University of Sydney, and author, with the late Prof. T. Jeffrey Parker, of "A Text Book of Zoology," aged seventy.

Dr. N. Kulchitsky, lecturer in histology at University College, London, and formerly professor of anatomy in the University of Kharkov, on January 29.

Dr. D. B. Spooner, deputy director of archæology in India since 1919, on January 30.

Prof. Hermann Schunck, a former director of the Badische Anilin- und Soda-Fabrik at Ludwigshafen, who retired in 1923, on January 8, at Solln near Munich.

Current Topics and Events.

ELSEWHERE in this issue appears an account of a remarkable discovery which appears to afford *prima facie* evidence of the occurrence at a remote period in South Africa of a pre-human stock, neither chimpanzee nor gorilla, and possessing a series of characters differentiating it from any anthropoid hitherto known. Fossilised fragments from a limestone cliff formation at Taungs, 80 miles north of Kimberley, in Bechuanaland, when fitted together, have revealed a natural endocranial cast with almost the entire face of what at first sight appeared to be an anthropoid, but on closer examination is found by Prof. Dart to exhibit humanoid rather than anthropoid characters. The occurrence of a fossil anthropoid so far south would in itself be sufficiently remarkable, but the interest and importance of this discovery is enhanced by its remarkable divergence from the anthropoid and its approximation to the human stock. Not only is this exhibited in the character of the cranium as a whole, but it is also apparent in the formation of the brain, so far as this is indicated by the endocranial cast. The position of the foramen magnum, if correctly estimated, in itself would indicate that this sub-human type was well on the way towards acquiring the upright posture, and the inference of an increase in intelligence which would follow upon a

freer use of the fore-limbs is supported by the development of the association areas of the brain, which is such as to indicate a marked advance in the growth of intellect. So far are we taken by Prof. Dart's preliminary report and the photographs which accompany it. A detailed examination of the evidence upon which his conclusions are based must await the publication of the monograph now in course of preparation. Within recent years, South Africa, in the discovery of the Boskop and Rhodesian skulls, has added remarkable chapters to the history of early man; but even the interest of Rhodesian man may well be eclipsed if the claim of *Australopithecus africanus* be substantiated. In this event, we shall have advanced one stage further, and that a stage of the greatest importance, in the quest for the cradle of mankind, whether that eventually prove to have been in Africa or elsewhere.

THE series of extracts from Dr. Birch's "History of the Royal Society," that have been appearing in NATURE week by week during the past year, reached a conclusion with the article published last week. But to Lancelot, Lancelot succeeds; "Early Science at the Royal Society" will be followed by "Early Science at Oxford," a somewhat similar series of extracts taken from the Minute Books of the Philosophical Society at Oxford between the years 1683 and 1690. By some the Oxford Society is regarded as the origin from which the Royal Society sprang. Certainly it was a fully organised body, with a constitution and officers, more than ten years before the London Society received its first charter, or recorded proceedings; and even in the papers of the Royal Society itself there are occasional early references to "an ingenious assembly" meeting in Oxford. The gatherings were, however, somewhat irregular owing to the fact that the members having no proper meeting-house, had to rely upon private hospitality, which made it difficult for them to accumulate books or collections, or even to arrange experiments. The building of the Ashmolean Museum, with a chemical laboratory in the basement and a room for the study of natural history on the first floor, provided the accommodation that was necessary for further progress, and on October 26, 1683, "The Company meeting in ye Naturall History School, desired Dr. Wallis, to take on him ye trouble of ye Chair; and appointed Mr. Musgrave to take ye Minutes of their Discourse." Extracts from Mr. Musgrave's minutes are now published for the first time.

ON December 15 last the Foreign Secretary, in response to a question in the House of Commons asked by Mr. A. A. Somerville, M.P. for Windsor, issued a Return giving full particulars of the Boxer Indemnity (Hansard's Debates, Dec. 25, 1924, p. 641, price 6d.; or Christian Industrial Fellowship, 4 The Sanctuary, Westminster, price 1d.). The Return enumerates not only the Powers concerned and the annual quotas paid to each, but also, in the case of remitting Powers other than Great Britain, the operative instrument and the stated purposes of remission, together with the machinery set up. One notable point of this illuminating document is that all the other remitting Powers (United States, Japan, Russia, France) have defined the purposes of their remission by statute or other legislative process, leaving to committees the task of carrying into operation the purposes thus defined. Another point common to all, except France, is that the purposes of remission are declared to be exclusively educational or cultural: even France makes a similar declaration, but its action is postponed until the debts of a state-guaranteed bank have been discharged. The remitted quotas—all of which continue until 1945—vary from 1,000,000*l.* a year (Russia) to 150,000*l.* (United States), that being all that remains of her original share of 260,000*l.* To Britain is due 400,000*l.* a year. The German and the Austro-Hungarian quotas, 700,000*l.* and 30,000*l.* respectively, were cancelled by the allies as a result of the War. The China Indemnity Bill is down for second reading in the House of Commons on February 13. The Government will, it is understood, introduce the late Government's Bill, as amended in committee. If, when the Bill becomes an Act, the present meaningless description of purposes is retained, an advisory committee, and not Parliament, will determine whether "educational or other" purposes shall, for example, be interpreted to include railways. It is hoped, however, that the Government may be induced so to define the purposes as to exclude this possibility; for though such a use of part of the fund might benefit a few contractors and employ a few engineers in China, it would certainly lower our prestige and alienate those for whom our remission of a just debt has been made.

PROF. W. J. DAKIN'S inaugural address on "The Teaching of Biology in Secondary Schools," delivered before the Liverpool Biological Society and published in vol. xxxviii., 1924, of the Society's Transactions, is a forcible pleading for the inclusion of biology as a subject of general education in school curricula. Not botany alone, or zoology alone; but the study of life-processes as manifested both in plants and in animals, the mutual relations of the members of the two kingdoms, and the bearings of both on human welfare—this is the type of biology that he advocates. Since in many schools botany is already taught, a large portion of the address is devoted to showing how zoology may, with a little foresight and slight expense, be likewise included in the teaching scheme. Difficulties that are feared, and objections that have been raised by some teachers, are discussed; and useful suggestions are offered by which apparent obstacles may be surmounted. An emphatic denial is given to the statement made in the Report of the Investigators of the Secondary School Examinations Council that "the principles of Biological Science can be better illustrated by means of botany, especially as physiology occupies a far more important part in the subject than in zoology, which does not readily lend itself to experimental treatment." There will doubtless be differences of opinion among teachers regarding the exact stage at which biology, in the full sense recommended by Prof. Dakins, can most

advantageously be introduced into the school time-table; but it is to be hoped that this address will be taken to heart and widely applied in those classes to which such teaching is appropriate.

DR. W. P. DAVEY, the research physicist of the General Electric Company of America, has produced a crystallised form of copper the electric conductivity of which is 13 per cent. better than that of ordinary pure electrolytic copper. Prof. Bridgman, of Harvard, was the first to discover that copper could be produced in relatively large crystals by the method of slowly heating it in an electric furnace and then cooling it equally slowly. On December 31, Dr. Davey described to the American Physical Society his success in producing copper crystals nearly an inch in diameter and six inches long. These specimens could be bent without effort, but once bent they could not be straightened again. This is attributed to the effect produced by the bending in upsetting the balance of the atoms of copper. The crystals seem to readjust themselves into small crystals again, so that for all practical purposes it becomes a bar of ordinary copper and is equally inflexible. By X-ray examination it was shown that the prepared copper was simply one large crystal, the atoms being arranged in regular rows from end to end. When the crystal was hammered it lost its super-conductivity. The new copper has a greater conductivity than silver. At present its manufacture on a commercial scale is not feasible, but Dr. Davey thinks that the time is in sight when it can be used for ordinary dynamos and conducting mains. As less copper would be required for a given service, it would cheapen the cost of conduits in underground work and of the towers required for overhead conductors.

SCIENTIFIC addresses by Sir Robert Hadfield are usually of a most comprehensive and enlightening kind, and that delivered by him before the Oxford University Junior Scientific Club on January 21 will delight all who see it in its published form. The address was entitled "Metallurgy and its Influence on Modern Progress," and it occupies about 190 pages, of which only a portion was read and illustrated by lantern slides and moving pictures. Amongst the plates in the published volume is a particularly interesting one showing Roger Bacon (1214–1292), one of the early founders of scientific thought in Oxford; the illustration represents Bacon, who wrote letters "of the Secrets of Arts and Nature" to the Paris University, presenting a book to the Chancellor of that University. By kind permission of the War Office and Admiralty, Sir Robert was able to show, in the course of his address, a cinematograph picture, taken by himself and his staff, of loading and firing a 15-inch gun at the Government Proving Ground at Shoeburyness, including a view of the butt one sixteenth of a second later showing the impact on the plate; one half second later showing large numbers of fragments flying from the plate and the butt; and finally the unbroken projectile, weighing nearly one ton, after it had perforated the thick, hard-faced armour plate against which it was fired. The sections devoted to metallurgy in the book cover about one hundred pages, in which Sir Robert refers to the importance of iron in antiquity, and the rise and importance of alloy steels. He gives a history of the invention by himself of manganese steel, silicon steel, and other alloy steels, and refers also to the value of heat treatment and the history of the pyrometer. In concluding his address Sir Robert directed attention to the importance of effort, progress and international co-operation, and suggested that there should be an annual Science Day to impress upon the community the place of science in modern life.

SIR OLIVER LODGE'S third talk on "Ether and Reality," delivered on February 3 under the auspices of the British Broadcasting Co. from the London Station, 2LO, was devoted to the electric charge and the means by which electric charges act on each other. The following are extracts from his instructive address:—Discoveries of the present century have shown (what had already been suspected by Faraday and Maxwell in the last century) that electric charges are discontinuous, like matter, that they exist as separate particles, although their field or region of influence extends throughout space. Moreover, electric particles or corpuscles are of two opposite kinds, which attract each other, and when very close together blot out each other's field at a distance and form a neutral combination. Particles which attract each other need not fall into each other, any more than the planets fall into the sun. The negative corpuscles can revolve round the positive, and thereby constitute a neutral group, with which we are familiar as an atom of matter. That is what an atom of matter is; that is what is meant by saying that matter is electrically constituted. The particles of opposite sign are called electrons and protons and are joined by lines of force, which represent something going on in the ether; all electrical phenomena can be expressed in terms of these lines of force. Lines of force represent a state of the connecting medium which unites electrons and protons and causes their apparent attraction. Similar lines account for cohesion. Gravitational lines of force unite earth and moon. We should always look for a medium, and we always find the ether operative in the physical universe; whether it is active in the mental universe we are not so sure. Mind usually acts on mind through a physiological mechanism; whether such indirect mode of connexion is always necessary is a subject for investigation. The laws of mental action may be quite different from physical laws; we should not let mechanism dominate us, for we may have to enlarge our conceptions.

"THE Mountain Structure and Geographical Relations of South-eastern Asia" formed the subject of a discourse delivered at the Royal Institution on Friday, January 30, by Prof. John W. Gregory. Prof. Gregory stated that the continuity of the Alpine-Himalayan system has been proved from western Europe to eastern India. Its further eastward continuation, according to one view, is across central China to Bering Straits; and according to another through western Burma to Sumatra and thence along

the southern islands of the Eastern Archipelago. Its diversion from its eastward course has been attributed to the mass of Chinese Tibet, the structure of which is complex, being due to movements at two different dates. The later movements belong to the series which made the Alps and Himalaya and are geologically modern. The other group is much older and is represented in Asia by the Altaid mountains. The most direct proof of the Himalayan movements is afforded where rocks which, as in the salt basin of Yunnan, were not in existence when the Altaid mountains were made have been intensely folded. At the end of the Altaid uplifts, the site of the Indian Ocean was covered by Gondwanaland, which extended from South America across the Old World to Australia. This continent was broken up by successive subsidences; and the gulfs thus formed gradually became the Atlantic and Indian Oceans. These movements were accompanied by volcanic eruptions, which deluged equatorial Africa and western India under floods of lava, while East Africa was torn asunder by the formation of the Great Rift Valley. One difficulty in the explanation of these eruptions and fractures by the foundering of the floor of the Indian Ocean was the apparent absence of any corresponding phenomena on its eastern side. The evidence now shows that Burma and western China were disturbed by volcanic eruptions and fractures contemporary with those of East Africa. The geographical relations of the mountains of south-eastern Asia therefore indicate that the Alpine-Himalayan system is part of a belt of crumpling of the crust where the in-sinking northern dome of the world pressed against the tropical and subtropical belt.

At a meeting of the Newcomen Society held on January 28 two historical papers were read, the first being by Mr. Hamilton, an American member, on "The Windmills of Cape Cod," while the second was by Mr. David Brownlie, and was entitled "Some Notes on a Neglected Worthy, John Patison of Airdrie." John James Patison was born at Leith in April 1828 and died at Inverkeithing in July 1905. Though his youth was passed in a bookshop and a bank in Edinburgh, he was able to start a salt works at Musselburgh, and afterwards, when he had removed to Airdrie, he began experimenting on the carbonisation of shale, and near Airdrie he established the Whiterigg Chemical Works. Mr. Brownlie referred to him as one of the earliest practical workers in the commercial development of the Scotch shale oil industry, though its real founder was, of course, James Young. The distillation of shale at Whiterigg ceased about 1864, a few years after the discovery of American petroleum. Patison was also the inventor of an internal screw conveyer retort, and Mr. Brownlie in his paper gives some interesting details of other inventors in the same field.

The rainfall of 1924 is dealt with in the *Meteorological Magazine* for January, but at present it is only possible to outline the general features. Over the British Isles as a whole, the year was unusually wet; the average fall was 48·5 in., which is 117 per cent. of the normal. It was wetter than any year since 1903, when the rainfall over the British Isles was 52·5 in. or 127 per cent. of the normal. In 1924 the rainfall was only slightly heavier than in 1916 and 1912, when the percentage of the average was 115 and 116 respectively. In parts of Scotland and the north of England, there were fairly large areas where the 1924 rainfall was deficient, and at Louth in Lincolnshire the rain was only 89 per cent. of the average. In England and Wales the rainfall for the year was 121 per cent. of the average for the 35 years, 1881–1915; in Scotland it was 105 per cent., and in Ireland 122 per cent. More than 140 per cent. of the average occurred on Dartmoor, on the Cotswolds, and to the north of London at Maidenhead and Chelmsford. At High Wycombe, in Buckinghamshire, rain measured 38·94 in., which is 13·04 in. more than the average, and is 50 per cent. above the normal; it is the largest fall, with the exception of that in 1903, since records were commenced in 1846. The London rainfall, according to the Camden Square records, was 33·08 in., which is 8·61 in. or 35 per cent. above the normal, the largest rainfall since 1916. Rain fell in London on 188 days, and the duration of rain for the year was 539·6 hours. January, May, September, and December were all very wet, whilst February and March were unusually dry.

The Hunterian oration in connexion with the Royal College of Surgeons of England will be delivered at the college on Saturday, February 14, at 4 o'clock, by Sir D'Arcy Power.

Sir William B. Hardy will deliver a lecture on "Problems presented by Films on Solid Surfaces," under the auspices of the Chemical Society, at 8 P.M. on Thursday, February 26, in the lecture hall of the Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W. Invitation has been extended to fellows of the Physical Society.

On Tuesday, February 10, at 5.15 P.M., Prof. J. Barcroft, Fullerian professor of physiology, begins a course of four lectures at the Royal Institution on the colour of the animal creation. The Friday evening discourse on February 13 will be delivered by Dr. B. Malinowski on the forces of law and order in a primitive community, and on February 20 by Prof. T. H. Pear on acquiring muscular skill.

The Minister of Agriculture and Fisheries has appointed a permanent committee to advise the Ministry on all questions relating to agricultural meteorology. The committee consists of:—Sir Napier Shaw (Chairman), Prof. V. H. Blackman, Mr. H. Corless, Mr. R. A. Fisher, Mr. J. C. F. Fryer, Mr. R. H. Hooker, Mr. R. G. K. Lempfert, Sir Thomas Middleton, Mr. J. Ramsay, Mr. H. G. Richardson; Mr. W. R. Black, of the Ministry of Agriculture, has been appointed secretary of the committee.

At the annual council meeting of the National Union of Scientific Workers, which was held at the University of London Club on January 31, the president, Prof. G. H. Hardy, announced that the efforts which the Union has been making for some

time past to obtain an increase in the Treasury grant to the Royal Society, in aid of scientific publications, have been successful. It is understood that, in the estimates for the coming financial year, the Government will make provision for an increase in this grant from 1000*l.* to 2500*l.* a year. The Annual Report of the Executive Committee records many other activities of the Union which are of interest and benefit, not only to members, but also to the scientific world at large. During the past year, three new branches have been formed, and the number of new members elected has been considerably larger than in previous years.

LAST month Mr. A. Cobham made a flight over the Himalayas. The *Times* gives some details of his journey. Leaving Calcutta he reached Jalpaiguri in 3½ hours, the object of this part of the journey being to survey an air route to Darjeeling. From Jalpaiguri he started his reconnaissance over the Himalayas, passing over Darjeeling at a height of some 9000 ft. Flying towards Kinchinjunga, Mr. Cobham experienced difficulties at about 12,000 ft., but after turning and descending, he returned and climbed without difficulty to 17,000 ft. At that altitude breathing was not easy, but temperature was not so low as at 12,000 ft. After taking a series of photographs of the range, Mr. Cobham returned to Jalpaiguri, having occupied only 3½ hours in his flight. He believes that the whole Himalayan range could be accurately surveyed from the air at a relatively small cost, and that a flight over Mount Everest would be easy.

THE arrears due to the War in the great *Index Kewensis* are being rapidly overtaken. The last pre-War Supplement, covering the years 1906–10, was published in 1913, and it was not until nine years later that it was possible to issue Supplement V., covering the years 1911–15. But Supplement VI., covering the years 1916–20, is now complete, and printing has begun at the Oxford University Press. We learn from the publishers that their stock shows that a large number of sets of the work have not yet been completed to date by the addition of Supplement V. (published in 1921), and they ask us to direct the attention of librarians to this fact. The value of the work, both scientific and pecuniary, is, of course, seriously impaired by the failure to complete sets; and the relatively low price at which the Supplements are issued has been made possible by the support given by librarians and learned institutions all over the world.

INTERMITTENT bournes are flowing in chalk areas in the south-east of England, and the Croydon bourne is no exception. It is probably not yet at its highest, but broke out as usual in the garden of the Rose and Crown, at Warlingham. It is now gradually creeping up the valley. More interesting is the fact that the Addington-Wickham Bourne is again out. This, after disappearing for about 33 years as a flow of any magnitude, appeared in June 1916, and is now again flowing, but it has passed its maximum. The gravel-pit which has been made in its path was covered by water, but not to any depth, and it is subsiding. This bourne is not directly on the chalk, but wells up through a thickness of tertiaries, and hence does not appear until these have been saturated. It is noteworthy as being in the valley which must have been at one time an upper reach of the Ravensbourne. Sodden patches which have been let down near its source seem to show that underground solution is taking place to some extent.

Our Astronomical Column.

THE OPPOSITION OF EROS IN 1931.—This opposition will be much the most favourable since Eros was discovered in 1898. Dr. Witt, who discovered the planet, has been engaged on the study of its perturbations up to 1931, and announces that he has now completed this work. The German observatories are now making arrangements for the careful observation of stars that lie near the planet's track, as they will be required as reference stars; they are also inviting co-operation in other countries.

The details of Dr. Witt's work are not yet published, but the following ephemeris, based on earlier elements, gives a general idea of the conditions during the time that the planet is within 19 million miles of the earth.

		R.A.	Decl.	log Δ.
1931.	Jan. 5	10h 17m	25° 16′ N.	9·306
	,, 13	10 19	17 32	9·264
	,, 21	10 16	8 45 N.	9·236
	,, 29	10 8	0 24 S.	9·226
	Feb. 6	9 56	8 44	9·238
	,, 14	9 45	15 31	9·265
	,, 22	9 35	20 10 S.	9·307

The maximum parallax, on Jan. 29, is about 52″.

Longer preparation is possible on this occasion than at the 1901 approach, and the minimum distance is little more than half so great; thus we may hope for a corresponding increase in accuracy.

THE U.S.A. NAVAL OBSERVATORY, WASHINGTON.—The report of the superintendent, Capt. E. T. Pollock, for the year ended June 30, 1924, has been published. In the Nautical Almanac Department, special investigations have been made of the orbits of the satellites of Saturn and Neptune. In the latter 1633 observations, ranging from 1889 to 1923, are included. A new catalogue of 1504 standard stars has been constructed and half of it is in type. The positions of the stars are a decided improvement on those in Boss's General Catalogue. Most of the Nautical Almanac for 1927 is in type.

The details are given of work with two transit circles and several equatorials; with these last, satellites and minor planets were observed. There were two dates when the sunspot activity showed a minimum, February 1923 and the end of August 1923. Numerous observations were made with the Prime Vertical Instrument: three determinations of the constant of aberration from these observations are 20·54″, 20·55″, 20·58″. All appear to be on the large side.

The Department for Training Naval Officers includes branches for studying the gyro-compass and the magnetic compass.

Research Items.

PRIMITIVE MURAL DECORATION IN SOUTHERN INDIA.—A paper by the late Dr. Nelson Annandale, published in vol. viii. No. 4 of the Memoirs of the Asiatic Society of Bengal, describes a primitive but effective form of art which is found in a Uriya village on Samal Island on the northern shore of Lake Chilka in Orissa. The people of Samal speak the Uriya language, but physically they are a mixed type, some showing traces of aboriginal blood while others present a Mongoloid appearance. Their culture is primitive and nominally they are Vishnuvite Hindus mostly of the Goala or cowherd caste. Some of the houses are composite, sheltering several families under one roof. The walls of the houses are uniformly covered with a wash of red earth forming the background of the decorations. The simplest form of pattern is made by applying the three fingers dipped in chalk and water to the walls. The more elaborate patterns fall into two groups, of which the character is indicated by their names. One is called *janar*, a kind of maize, the other *punjha pareda*, "four coconuts," of which, however, only three can be distinguished as a rule. These patterns are usually executed by men. More elaborate designs also are in use, some made by women, in which birds and fishes appear. Most of the interior decorations were painted in several colours, while some of those used in internal passages were mythological. Outside are certain lucky signs, such as double fish and footprints; the object of the decorations seems to be purely æsthetic.

ARCHÆOLOGICAL REMAINS IN NEW ZEALAND.—In vol. ii. No. 4 of the Records of the Canterbury Museum, Mr. H. D. Skinner continues his description of the objects found in caves near Christchurch, N.Z., opened in 1889, which were sent to the Otago University Museum in 1922. The material from Monck's Cave, which is situated about a mile east of the Moa-bone Point Cave previously described, although more interesting than that found in the latter, is scientifically of less value, as no record was kept of its stratification. Sixteen pieces of moa bone were sent to the Museum, eight of which were worked. One of the most interesting articles found was a carved bailer, the only known example from South Island, which, with a paddle, was found immediately the cave was opened. It is therefore probably of later date than the moa-hunter age. Its decorative *motif* of a bird's head and loop coils was not previously known from this district. An outrigger float is the only New Zealand example which has been preserved. Of a number of adzes, several were Polynesian in form but none of West Pacific types. Among a variety of other articles were a toy canoe and paddle and a toy dog, which confirms the accounts of Maori dogs given by early travellers. One of the most interesting discoveries was a series of cuttings of human hair showing a considerable variation in pigmentation, ranging from dark brown to chestnut. Its very fine plaiting points to Polynesian relationship.

COLOUR FATIGUE IN THE EYE.—In a pamphlet (reprinted from *The Medical World*) Dr. F. W. Edridge-Green, who is special examiner and adviser to the Board of Trade on colour vision and eyesight, quotes the following passage from Dr. Troland on minuthesis (that is, colour fatigue): "The general conclusion to be drawn from the work is, therefore, that minuthesis due to one colour does not alter the luminosity of another colour to a degree differing appreciably from that in which it is altered itself. In other words, the change in sensitivity to brightness occasioned by stimulation of the retina is independent of the wave-length constitutions of the minuthetic and of the reacting lights. This seems to imply that the luminosity function is not essentially linked with the colour or chromatic function, and stands in contradiction to the views of Abney, Ives, and others, who treat luminosity as the sum of the primary colour values of any stimulus. The present results appear also to be in conflict with experimental data along similar lines published by Abney and by Burch, so that further study of the problem would seem to be required on a larger number of subjects." These conclusions are in agreement with those to which Dr. Edridge-Green himself and co-workers have come (see "Physiology of Vision," p. 248, Proc. Roy. Soc., 1912).

LARVÆ OF DECAPOD CRUSTACEA.—Notwithstanding the strange forms they frequently assume, the larvæ of decapod Crustacea have in recent years received very little attention at the hands of zoologists. This is no doubt due to the great labour involved in linking up unknown forms with parents which often have a widely different appearance, and to a fear that, when all is done, little real advance will have been made in our knowledge of the group. In his report on the larval decapods obtained by the British Antarctic (*Terra Nova*) Expedition (Crustacea, Part IX. British Museum (Natural History). 1924. Price 15s.) Mr. Robert Gurney has shown that such studies may yield indications of great phylogenetic importance. Although the numbers of known larvæ are still few in comparison with adults, it is clear from Mr. Gurney's work that a classification derived from them will sometimes diverge in a striking manner from the system generally adopted. This system, based mainly on the morphology of the adult decapod, is none too securely founded, and there is little doubt that a knowledge of the larval structure will be of great assistance in its revision. Two of the more important conclusions that Mr. Gurney has reached are that the Stenopidea should be removed to the Reptantia, and that the Thalassinidea are not homogeneous, but fall into two divisions—a Homarine series, including the Axiidæ and Callianassinæ, and an Anomuran series, including the Laomediidæ and Upogebiinæ. A feature that will appeal strongly to every student of the group is that in Mr. Gurney's work he is provided, for the first time, with a systematic presentation of all available information on decapod larvæ. Under most of the family headings the principal larval characteristics are summarised or discussed, and there is a valuable list of references to the widely scattered literature.

THE TANNING QUALITIES OF MANGROVES.—In *Indian Forest Records*, vol. x. part x. for 1924, Mr. J. A. Pilgrim has an interesting account of the mangroves of Tenasserim as a possible source of supplies of tannin. The writer was appointed tannin expert to the Government of India with the idea of surveying from this point of view the mangroves of Burma, but as delay was caused in this project through the War, he has in the meanwhile carried out an investigation of the mangroves of the Sundarbans of Bengal, and thus is able to compare his Burmese results with further data obtained in more northern latitudes. Pilgrim points out that whilst on the whole the mangroves of the Sundarbans and of Tenasserim show no noteworthy differences, yet on the whole, (1) the best of all the mangrove tans, and (2) the commonest of these tans, both show themselves richer in tannin in the more southern

latitude. The best source of tannin is said to be *Carapa moluccensis*, the commonest *Rhizophora mucronata*. This latter species has been widely collected, and Pilgrim points out that it has shown itself richer in Borneo than in the Philippines, whilst chemists in Sarawak, S. Borneo, get somewhat higher yields of tannin than Pilgrim from N. Borneo, and now the Burma material proves more valuable than that from Bengal. The writer concludes that his present results seem to support the general thesis that mangroves increase in tannin content as they approach the Equator.

OVERSEAS TRANSPORT OF APPLES.—Early in 1923 a scientific expedition, consisting of Dr. Ezer Griffiths, Mr. A. J. Smith, and Mr. Edgar A. Griffiths, was sent by the Food Investigation Board to study problems involved in the transport of apples from Australia to England. Special Report No. 20 of the Board, entitled, "The Problems of Apple Transport Overseas," by Drs. Kidd and West (H.M.S.O., price 9*d*. net), is a general survey and summary of the results obtained. The investigation originated in an inquiry as to whether the disease known as "brown heart" could be correlated with the atmospheric conditions in the holds in which the apples were carried. Four boats, representative of the different systems of marine refrigeration in use, were studied and a complete record obtained of the carbon dioxide content of the atmosphere of the holds, and of the temperature distribution in the interior of the cargo of apples. One surprising result observed was the magnitude of the accidental ventilation which takes place due to leakage; calculations based on the estimated rate of production of carbon dioxide by the respiration processes of the apples and the periodic measurement of the amount of gas present in the hold show that, in one of the boats studied, about 300 cubic feet of air per day per ton of apples finds its way into the hold. This was the case of a boat equipped with forced circulation of the cooled air. In a boat depending on convection currents from cold brine pipes for the cooling effect, the leakage was considerably less and the accidental ventilation was only just sufficient to keep the carbon dioxide concentration below the danger limit of about 10 per cent. Another important result of the expedition was to show that none of the present systems employed for the stowage of the apple cases produced a uniform temperature distribution throughout the mass. This is a problem which is now being studied at the National Physical Laboratory by the aid of scale models. The expedition also afforded an opportunity for observing under marine conditions the behaviour of various types of physical apparatus used in the investigation, such as electrical thermometers, carbon dioxide indicators, hygrometers, and anemometers.

PETROLEUM IN THE LOST SOLDIER-FERRIS DISTRICT, WYOMING.—Messrs. A. E. Fath and G. F. Moulton, of the United States Geological Survey, have recently completed their work in this interesting area of south central Wyoming, an area in which there has been active oilfield development since 1916. The results of the survey are contained in Bulletin 756. The geology conforms with that characteristic of the Big Horn Basin as a whole, and, as would be expected, Cretaceous beds constitute the most important stratigraphical and economic formations. In this area of about 600 square miles, the authors have described nine domes and anticlinal folds with which oil and gas are associated; these local structures, regarded as being post-Oligocene in age, are superimposed on what is known as the Rawlins Uplift, a regional structure of early Tertiary or even older achievement. Some difficulty was experienced in mapping the district owing to the outcropping formations being much concealed by alluvial wash and blown sand, but two of the domes, Lost Soldier and Bunker Hill, are indicated topographically, especially the first, which accounts for its earlier development as an oilfield. Faulting has affected the structures considerably, most dislocations cutting across the flanks of the folds; this naturally has a marked influence on the distribution of the oil-sands involved. In 1921 the Lost Soldier field produced 380,811 barrels of oil from 28 wells; in the same year the Ferris Dome produced 16,740 barrels, and what is known as the "G.P. Dome" yielded 74,199 barrels from 3 wells. On another, the Mahoney Dome, a rich gas sand was encountered with an open-flow yield estimated at 50,000,000 cubic feet of gas per day; lightning ignited the gas and the well burned for 27 days before being extinguished, which was accomplished by exploding a 25-pound charge of dynamite close to the well-mouth, taking advantage of the momentary slowing down of the gas flow and then snuffing with steam. These and other significant facts indicate that the area has decided commercial possibilities, though accessibility and questions of transport and marketing of the oil are problems which apparently are only just being solved.

WIND DIRECTION, CLOUD AND VISIBILITY.—The Meteorological Office, Air Ministry, in Professional Notes, Vol. 3, No. 36, gives a discussion "On the inter-relation of wind direction with cloud amount and visibility at Cahirciveen, Co. Kerry," by Mr. L. H. G. Dines and Mr. P. I. Mulholland. The object is to ascertain whether there is a statistical relation of sufficient magnitude to aid in forecasting the amount of cloud and visibility at night from observations in the afternoon and evening. The data for cloud cover a period of ten years from 1911 to 1920. South winds are the most common, followed by south-west and west. The outstanding feature is the excessive amount of cloud with south winds in each season and at different hours of the day. The clearest skies occur with calms in spring and north-east winds in winter and autumn; a clear sky may be expected, with either, once in 5 or 6 times on the whole, as against once in 77 for south-west winds. For the inter-relation of wind direction and visibility the data employed are for about two years, 1919 and 1920. As a rule, visibility at Cahirciveen is good, the best occurring with northerly winds, the poorest with southerly, the latter being due to the generally damp conditions prevailing with such winds. The authors deal with the Beaufort letter "v," unusual visibility, as a sign of coming rain, and so far as Valencia Observatory is concerned, observations there do not support the old theory. Much more proof than observations at this special observatory will be required substantially to disprove its general applicability. As a standard for normal humidity, the observations for 1886–1910 are used; it must not be overlooked that a good many years ago the position of Valencia Observatory was shifted from an island to the mainland.

METAL-CLAD ENCLOSURE OF CONDUCTORS.—The tendency of modern electrical engineering is to devise automatic operation to replace manual operation, and so provide "mistake-proof" plant. As the voltages of transmission, owing to the large amounts of power that have to be transported, are continually being raised, it is necessary also to devise methods of making contact with a "live" conductor a practical

impossibility. Mr. H. W. Clothier, in a paper read to the Institution of Electrical Engineers on January 22, gives a very able discussion of these and similar problems. He points out that the ideal arrangement is to enclose metallically every conductor so that it is completely inaccessible when alive. These metallic covers are connected with the earth, and if they be used over the whole supply system from the generators to the load, they provide practical immunity from burns and shocks. If this method is carried to its logical conclusion, overhead lines would have to be replaced by underground cables. The initial cost, however, of high-tension underground cables is at present in most cases prohibitive, and so compromises have to be arranged. It is also of importance that faults occurring in a transmission system should be rapidly cleared, as in several cases high-frequency currents are set up in the system, and these produce very serious electromagnetic interference with neighbouring telephone and telegraph lines. Shocks and fires from this form of interference are an appreciable "risk," and have to be taken into account. The author concludes that, for safety of the operators and continuity of the supply, the use of universal metal-clad enclosure is highly desirable. There should always be a stable neutral point on the network maintained at earth potential, and all operating mechanisms should be thoroughly trustworthy and be periodically inspected.

THE POLYMORPHIC FORMS OF IRON.—The issue of December 5, 1924, of *Die Naturwissenschaften* contains an interesting summary by F. Wever on the physics of the technical varieties of iron. The remarkable variation of properties of this material which makes it so valuable a substance depends essentially on the fact that iron can be obtained in several polymorphic forms, the behaviour of which towards carbon, which invariably accompanies such iron, is very different. The author reviews the properties of the polymorphic forms of pure iron, of which there are four, namely, α, β, γ, δ. The lattice forms of α-, β-, and δ-irons are the same and are those of a body-centred cube, while that of γ-iron is a face-centred cube. The maximum solubility for carbon is possessed by γ-iron and corresponds to 1·8 per cent. at 1140°. δ-iron, which only exists between 1535° and 1410°, can dissolve 0·38 of carbon at the latter temperature. In contrast with this the solubility of carbon in β- and α-iron is extremely small. The properties of iron carbide and the relations between iron and carbon are discussed in the latter part of the paper, which concludes with a brief summary of the theory of hardening. The author favours the theory of Maurer, according to which carbon is in a condition of atomic dispersion in α-iron, the volume of which is thereby decidedly increased. The condition of strain thus induced is regarded as the cause of the exceptional hardness of such steel.

THE SILICA OF PLANTS.—D. R. Nanji and W. S. Shaw have recently found (*Chemistry and Industry* Trans., Jan. 2) that about 90 per cent. of the total silica occurring in plants is present as free silicic acid, probably in the colloidal state. The remaining 10 per cent. is in a form from which it can only be extracted after preliminary treatment with acid, probably as an ester-like combination with a polysaccharide constituent of the plant.

THE IDENTITY OF GEBER.—E. J. Holmyard, in an article on the present position of the Geber problem in *Science Progress* for January 1925, considers it definitely established that Geber is Jābir ibn Ḥayyān. The Latin works ascribed to Geber are probably not literal translations from the Arabic, but are works based on Arabic knowledge. There is not sufficient evidence at present definitely to state that these Latin works are genuine. A study of the works of Jābir confirms his reputation as the greatest chemist of Islam.

THE ULTRA-CENTRIFUGE.—Svedberg and Rinde, in the Journal of the American Chemical Society for December 1924, describe a new instrument, the ultra-centrifuge, for the determination of the size and the distribution of size of particles in amicroscopic colloids. It enables particles which are invisible in the ultra-microscope to be measured. The theory of the instrument is given in detail; measurements of the radius of the particles of gold sols (average radius 2·3-11·6 $\mu\mu$) made with this instrument give values 11-38 per cent. higher than those obtained by Zsigmondy's nuclear method. The nature of the protective action of gelatin upon fine-grained gold sols is also studied, minimum and maximum values for the thickness of the gelatin layer adsorbed around the gold particles being obtained.

CRYSTAL FORMATION.—The development and formation of crystals is the subject of a paper by Dr. T. V. Barker in *Chemistry and Industry* for January 16. Among the topics discussed are: lattice structure; polymorphism and isomorphism; mixed crystals; chemistry of the crystalline condition. The main lines of advance in the X-ray examination of crystals are outlined. The section on crystal mixtures is somewhat detailed. The equilibrium relations between a mixed crystal and its mother liquor are most simply illustrated by leaving out of account the variable amount of water (or other solvent) requisite for solution, and then plotting percentage composition by weight of the two constituents of the mixed crystal against their relative proportions in the solution. Two types can then be distinguished, the first of which is illustrated by mixtures of cobalt and ferrous sulphates, and the second by mixtures of potassium permanganate and perchlorate (Muthmann and Kuntze). The complete equilibrium diagram of ferrous and magnesium sulphate mixtures is given for the first time; the system belongs to the second type.

LOW TEMPERATURE TREATMENT OF BITUMINOUS MATERIALS.—T. W. S. Hutchins, at a joint meeting of the Chemical Engineering Group and the London Section of the Society of Chemical Industry on January 16, gave an account of the low temperature treatment of bituminous materials. He set out by cataloguing the conditions which must necessarily be fulfilled if such a process is to be technically successful. It would seem that these conditions are extremely stringent, for the number of such "points" (in the Wilsonian sense) reached twenty-two. He described the development of the "fusion" retort and its construction as at present used. It consists of a horizontal, revolving, externally heated retort through which the comminuted material passes. The retort contains a series of paddles on a free horizontal shaft, so that when the retort revolves, these paddles roll over in such a way as to churn up the charge, facilitating the escape of vapours and at the same time preventing the growth of accretions on the walls of the retort. It would seem that the plant is designed primarily for the recovery of liquid distillation products, and the yields obtained from a number of bituminous materials are given, but without data to indicate how far the processes are commercially successful.

Scientific Work of the Fishery Board for Scotland.[1]

AMONGST the points of scientific interest in the report for 1923 of the Fishery Board for Scotland are the facts pertaining to the continued abundance of all kinds of fishes, swarms of small haddocks especially being noted. Thus the total capture was little short of that in 1919, though exceeded by that in 1920 when the rush of boats was at its height. Herrings show no sign of diminution even under the unfavourable conditions of capture, the returns much exceeding those of the previous year, and almost reaching those of 1913.

The work of the scientific staff includes a paper of special interest by H. Thompson on "Problems in Haddock Biology," which has already been noticed in NATURE (August 30, p. 333).

Alex. Bowman treats of Arnoglossus and especially of what he thinks a post-larval *A. imperialis* (with a coloured figure). He remarks that *A. laterna* has a similar distribution to the sole (*Solea vulgaris*), and asks what are the factors which have prevented its establishment on the East Coast of Scotland by Nature or by transplantation. The sole has always, however, occurred sparingly on the East Coast in such bays as St. Andrews, and the transplantation of about 600 from Scarborough to this bay has had little effect on its abundance. He points out that other species of Arnoglossus enter by the Strait of Dover and reach the Skager Rack and the Cattegat, whereas he thinks *A. imperialis* must have reached the northern North Sea (where 3 young specimens were found) from the Atlantic, and that they do not survive. Possibly investigations both of the life-histories of the several species and of the various currents may afford further information. The efforts by the same author to locate the areas in which the herring spawn by the capture of what he terms "spawny" haddocks which "are well fed and plump of form, and have a characteristic bloom on the epiderm which masks the black pigment," seems to be somewhat far-fetched, for, whilst no less than 80 boxes of large haddocks may be caught where the herrings spawn, no more "bloom" occurs on those with their stomachs full of ova than on those caught by the liners on other grounds. Again the cod, which feeds on the ova of the herring no less greedily than the haddock and even scoops up quantities of gravel with this food, presents no external change. No doubt such investigations are useful on unknown ground—though the external changes are more or less imaginary.

In a careful contribution on the use of the Petersen grab, A. C. Stephen perhaps makes too much of this instrument, which, though a useful adjunct to other methods of ascertaining the fauna of the sea-bottom, such as the dredge and the trawl, falls far short of the revelation a single storm will disclose on the beach. Not all the elaborate calculations of this and that species per square yard brought up by the grab will add more to our knowledge than the storm. It is curious that neither Pecten nor Nephrops (the rich food of the cod) seems to have come in the way of this instrument in the area of the Firth of Forth.

An interesting digest of the summer herring fishery of 1922 is made by H. Wood, whose observations and the accompanying map point to the occurrence of shoals in the same areas from June to September, the shoals perhaps differing in their composition, but still affording good catches. He found that the northern large herrings spawned before the southern, and he makes remarks on the spawning areas and the times of spawning, an intensive period being the end of August.

An elaborate and interesting paper is that by Prof. D'Arcy Thompson on the trawling statistics of Aberdeen from 1917 to 1921, in continuation of that issued in 1917, the period comprising two of the War years and three of unusual activity. These statistics again emphasise the fact that the old East Coast fishing grounds are as productive as formerly, the value of the catches being more than doubled, and this in face of the usual pessimistic views of the sea-fisheries. Whilst the post-War catches were much above the average, it is noteworthy that in 1917 the captures of codlings rose considerably, indeed were greater than in any previous year, and continued at a high level until 1920. Cod were much in the same condition. Haddocks, which had been rather scarce in 1914 and 1915, went beyond pre-War levels in 1916 and continued to increase until 1919, the average per voyage being nearly four times that of 1913, and, though diminished in 1920 and 1921, were still above pre-War catches. The advocates for accumulation during the War would point to this as proof of their theory, but such irregularities have often occurred previously and will occur in the future.

An important addition to the scientific equipment of the Fishery Board is the new Research Laboratory, a brick building of one story, with various rooms for the staff, besides a museum and library. It is within easy reach of the Bay of Nigg and Torry Harbour, Aberdeen. The Fishery Board apparently at present assumes responsibility for these researches, which do it credit, but perhaps in future it would be well if, as in the case of the Royal Society, the caution were prefixed that the Board does not accept responsibility for the views of the authors.

W. C. MCINTOSH.

[1] Forty-second Annual Report, Fishery Board for Scotland, being for the year 1923. (Edinburgh: H.M. Stationery Office, 1924.)

Science and the Instrument Industry.[1]

THE British Scientific Instrument Research Association is fortunate in that most of its members are, by the nature of their work, in constant contact with research, and consequently in a position to know what it implies, and understand its methods and results. Many of these participating firms have, in fact, long been in the habit of carrying out original investigations in their own laboratories. They realise, therefore, the lines along which advance is possible and desirable, and, what is most important, they have had experience in formulating their problems in a scientific manner. On the other hand, the research staff of the Association has learnt to envisage the problems put before it from the manufacturer's point of view, and to adapt itself to practical needs and the limitations imposed by the necessity of economic production. The efficiency of this staff is very largely due to the good fortune of the Association in having as its director of research Sir Herbert Jackson, who is not only known for a variety of pioneer investigations in the realms of pure and applied science, but has also had a particularly wide experience of matters concerning instrument design, and of the psychology of the manufacturer. The Association is largely a body of his shaping, and he has made it a scientific instrument for the setting and solving of problems fundamental for the industry concerned.

The sixth annual report of the Association has just

[1] The Sixth Annual Report of the British Scientific Instrument Research Association, for the Year 1923–24. (London: 26 Russell Square, W.C.1.)

appeared. At the end of it will be found a list of twenty-nine research reports which have been issued to members, to whom, of course, they are confidential. This is necessary to protect the participating firms against both foreign competitors and those British firms, fortunately few, which have elected to remain outside. Very fittingly, both on account of the intrinsic importance of the subject to the instrument industry, and because the director is the leading authority on the chemistry of glass in Great Britain, a large number of these reports deal with problems concerning optical glass, such as the production of special glasses, including one asked for by the Admiralty; the preparation of neutral and coloured glasses; and the stabilising of polished glass surfaces, that is, the rendering of such surfaces immune from secular changes and the effects of climate. This problem of stabilisation, and many of the other optical glass questions, are of particular importance to the fighting services, which depend so much on the use of optical instruments in a variety of conditions. The fighting services are represented on the Council of the Association by representatives appointed by the Department of Scientific and Industrial Research, and their presence emphasises one of the services which the Association renders to the nation. Evidence of the activity of the Association on the electrical side is offered by researches on magnetic properties of materials used for galvanometer suspended systems, and on certain X-ray problems.

That the importance of the work done is realised by the Department of Scientific and Industrial Research, which controls the Research Associations, is indicated by the recent history of the Association, contained in the present report. The Association has completed the first six years of its existence, and with them the period of its initial grant. After investigations of the work of the Association by a special committee, including such experts as Sir Richard Glazebrook and Sir James Walker, the Department has resolved to offer an annual block grant of 10,000*l.* on certain conditions which have been accepted, so that the Association has already entered upon its second grant period. This period is characterised by certain administrative changes, among which the most important are those which bring the fighting services into closer touch with the Association, making them virtually members.

The value of the Association to the instrument industry is not easily overestimated. Apart from the actual researches which it carries out, it is often able to answer questions straightway from the knowledge which it has accumulated. It acts as a centre of scientific activity, and has effectively introduced a spirit of co-operation among the participating firms, which is of the greatest promise for the future ability of the industry to excel foreign competitors. The trust reposed in the director by all the members leads to a collaboration which would otherwise be quite impossible owing to trade rivalry, and there has already been an intercommunication of trade processes which has greatly benefited, for example, the various optical firms. Different firms, working in close touch with the research staff, have carried out in their own works and laboratories particular researches for which they have special facilities, and the results have been freely put at the disposal of all members. This policy has already led to the production of certain instruments equalling, if not surpassing, those put on the market by foreign firms which, before the War, were supposed to be unapproachable.

Between the National Physical Laboratory and the Association there exists a goodwill which is evidenced by the collaboration which has already taken place over the question of testing lenses by the Twyman interferometer and over certain other problems, such as the production of resistance wire. The Laboratory has always been a source of strength to the instrument maker in a variety of ways, but in the Association he has an engine which enables him to help himself in a way which no outside body can do. Round the council table and in the sub-committees the members can thrash out questions both of technical design and of policy, avoid duplications of effort, and hear from one another and from outside members practical criticism and practicable suggestions, while the work of the research staff not only solves individual problems but also keeps constantly before them the high ideal of producing instruments not as good as, but better than, any yet on the market.

The Botanic Garden, Copenhagen.

PROF. OSTENFELD has prepared as a jubilee publication an account, referred to below,[1] of the history and resources of the Botanic Garden at Copenhagen. The contents of the work include many details of historical interest, while the botanist looking around for a continental school of botany will find much useful information in its pages.

The Botanic Garden, now fifty years old, is the successor of one that, dating back to the close of the eighteenth century, had become inadequate. Until 1871 the site was part of the old fortifications of the city, but by 1874 about twenty-four acres were transformed. The old moat, rounded off, still exists as a lake, the view-point from which one sees the features of the garden extending in pleasant vistas up the rising ground on every side. Here the stately greenhouses, there the rock-garden, and in the background one or other of the scientific and public buildings which adjoin the garden. In recent years the trees have been collected into a special arboretum at Sorö, thus allowing space for a considerable extension of the rock-garden, and for special sections. Thus in the "Danish quarter" miniature chalk cliffs harbour the plants of Möen, and on other rocks and soils the native Danish plants are seen in their normal environment.

The biological section is occupied by typical growth-forms such as might be expected in the home of Eugene Warming. The extensive glass-houses, in a compact block of more than 2000 square metres, include the higher palm-houses and lower ranges where tropical plants, orchids, aquatics, and other groups are housed. The more noteworthy plants, indoor and outdoor, are illustrated in the jubilee volume from photographs. The botanical museum shelters a mass of material, including special Danish, Arctic, and West Indian collections. The list of herbaria, more than two pages, is useful for any proposing to utilise them. The library of 25,000 volumes has been enriched by numerous donations. The Botanical Laboratory, dating from 1890, is a spacious block which is illustrated by a plan and photographs.

This home of Danish botany has been directed during the past fifty years by Joh. Lange, F. Didrichsen, E. Warming (1885–1911), and C. Raunkiaer, who was succeeded last year by C. Hansen Ostenfeld. The lists of staff include W. Johannsen, L. Kolderup Rosenvinge, F. Borgesen, and many others whose work has enriched the literature of botany. Copenhagen has many advantages as a centre for the study of northern floras, and this memoir will prove a useful source of reference.

[1] "Botanisk Have gennem 50 Aar, 1874-1924." By C. Hansen Ostenfeld. Pp. 101. (København: G.E.C. Gads Forlag, 1924.) n.p.

University and Educational Intelligence.

CAMBRIDGE.—J. T. Irving, Gonville and Caius College, has been elected to the Benn W. Levy Research Studentship in Biochemistry.

The Governing Body of Emmanuel College offer to a research student, who is a candidate for the Ph.D. degree, a studentship of the value of 150*l.* a year for two years. Application should be made to the Master of Emmanuel College not later than July 31.

DUBLIN.—The Regius professor of physic in Trinity College, Dr. John Mallet Purser, has made a gift of 10,000*l.*, for the benefit of the Schools of Physic and Experimental and Natural Science, to be administered by a committee consisting of Prof. J. Joly, Prof. A. F. Dixon and Prof. W. E. Thrift. The Board of Trinity College, in gratefully accepting this most generous gift, has expressed to Prof. Purser its desire that he should associate himself with the committee in the administration of the fund. Prof. Purser has been connected with the teaching staff of Trinity College, Dublin, for 28 years, and during that period he has been to staff and students alike a source of inspiration and help, in the same way that Sir William Osler was to the scientific and medical schools at Oxford. Prof. Purser's many friends and pupils, not in Ireland alone, but in all parts of the world, will express the hope that he may long continue to hold his high position, and that he may still for many years to come preside over the School of Physic in the University to the service of which his life has been devoted.

LONDON.—A bequest of 5000*l.*, subject to certain life interests, under the will of the late Mr. Arthur Jubber, has been accepted, the interest thereon to be used for scholarships, prizes, or lectures in any advanced subject, especially chemistry, botany, mathematics, ancient, modern, and natural history.

The recognition of the London School of Economics as a School of the University in the Faculty of Arts has been extended to include the subjects of history and anthropology.

The income of the Laura Soames Trust Fund for Phonetics is to be used for an annual prize in that subject.

The degree of D.Sc. (*Chemistry*) has been conferred on Mr. George Dean (West Ham Municipal College) for a thesis entitled "The Atomic Weights of Carbon and Silver."

The election of examiners for the matriculation examination for 1926 in the subjects of ancient history, botany, geography, geometrical and mechanical drawing, German, Greek, and modern history will shortly take place. The necessary application form and particulars of the duties and remuneration of the office may be obtained from the External Registrar of the University, South Kensington, S.W.7. The completed form must be sent to reach the External Registrar by Monday, February 23, at latest.

MANCHESTER.—The Council has received from the General Electric Company of the U.S.A. the gift of an X-ray spectra apparatus for use in the Department of Physics.

The following appointments have been made:—Mr. B. A. McSwiney to be tutor and secretary to the Faculty of Medicine; Mr. B. Thomsett, assistant lecturer in electrical engineering in the Faculty of Technology; Mr. H. E. Martin, Whitworth meteorological observer.

The following resignations have been accepted:—Mr. H. Lowery, of the Department of Physics, on his appointment to a lectureship in the Technical College, Bradford; Mr. Ferris Neave, research assistant in entomology, on his appointment to a lectureship in the University of Manitoba.

OXFORD.—As was generally expected in the University, the vacancy in the Wardenship of New College has been filled by the election of the Right Hon. H. A. L. Fisher, member of Parliament for the Combined English Universities, and formerly president of the Board of Education. As a Wykehamist in the fullest sense, Mr. Fisher is certain to enter upon his duties as Warden of Wykeham's Oxford college with understanding and sympathy; while his distinguished career as an educational and administrative authority justifies the confidence which is widely felt in his ability to deal with the large questions of policy at present affecting the whole University. There is every reason to believe that Mr. Fisher, although his work as a writer and teacher has mainly lain in the department of modern history, will make his influence felt in the promotion of the best interests of natural science.

SIR AUBREY SYMONDS, second secretary of the Ministry of Health, has been appointed permanent secretary of the Board of Education, in succession to Sir Amherst Selby-Bigge, Bart.

THE annual distribution of prizes and certificates at the Sir John Cass Technical Institute, Aldgate, London, E.C.3, will take place on Tuesday, February 10. The awards will be distributed by Mr. Sydney O. Nevile, past-president of the Institute of Brewing, who will afterwards deliver an address on "The Fermentation Industries."

IN conjunction with the Development Commission the Departments of Agriculture for England and Wales and Scotland have instituted a new class of scholarships with the object of training those who desire eventually to take up posts as agricultural organisers or lecturers. The scholarships are of two years' duration, the first of which will be spent on investigational work in Great Britain and the second abroad. The scholarship allowance in the first year will normally be 200*l.*; the allowance in the second year will include provision for extra cost of travel and other expenses abroad. The Development Commissioners have approved of the following awards—the first under this scheme: H. D. Bennett (University College, Reading), F. H. Garner (University of Cambridge), V. Liversage (Harper Adams Agricultural College), T. Lewis (University College of North Wales), and A. D. Imper (Marischal College, Aberdeen).

FROM the Imperial College of Tropical Agriculture we have received a copy of its first detailed prospectus. The College, opened two years ago, trains students intending to become tropical planters, agricultural administrators or officers, or specialists, and offers facilities for study to graduates of other institutions. An important feature of the College is the provision for research and investigation which is afforded by its laboratories and fields, situated at St. Augustine, seven miles from Port-of-Spain in the Island of Trinidad. There are seven professors—of zoology and entomology, mycology and bacteriology, botany and genetics, chemistry and soil science, agriculture, economics, and sugar technology, and four lecturers, including one in veterinary science. The ordinary diploma course covers three years. Fourth year courses are provided for specialisation in branches of agricultural science or chemical technology, in particular, sugar technology, and short (one-year) self-contained courses are also provided. The College is at present non-residential.

Early Science at Oxford.

February 8, 1683–4.—Mr. Desmasters gave us a farther account of ye expansion of Ice. He told us, that whereas the water he made use of lately (in some experiments of this kind, mention'd in the preceeding Minutes) was a sort of rough pump-water, which he has found turn milky and turbid immediately upon ye affusion of oyl of tartar *per Deliquium*; and considering also, that ye Ice made of this Water was a sort of rarified white Ice, he was hereby inclined to try, whether River water (which would readily mix with oyl of Tartar, without ye least precipitation) would, upon freezing, be expanded to ye height of ye pump-water above mentioned. In order whereunto, he fill'd a glass tube of almost an inch diameter, with river water, to ye height of 6 inches (as he had done in ye former triall,) and then putting it to freeze in a mixture of snow, and salt, it gained but $\frac{5}{8}$ of an inch, after it was frozen; whereas ye pump-water got $\frac{7}{8}$ of an inch.

Dr. Plot shew'd us some *Rosemary balls*, which are of ye nature of Mr. Lister's Rust-balls, and were dug in Staffordshire, where they lye in lumps, in some of their Marl-pits. Part of this stone apply'd to ye Magnet, after an hour's calcination.

A letter from my Lord Bishop of Ferns and Leighlin, mentioned a discourse of his Lordship's, preliminary to ye Doctrine of Sounds included in his letter. We received also a discourse from Mr. William Molyneux, concerning an optical Problem, which was read, and transmitted to ye Royal Society; Mr. Bernard is desired to peruse, and consider it, as soon as it shall be returned from ye Royal Society, and give his thoughts of it to ye company.

February 9, 1685–6.—An Abstract of ye book of Fishes composed by Mr. Willoughby and Mr. Ray, printed by ye Royal Society, was read.—Mr. Cole of Bristol communicated an account of his observations on ye Purple Fish, for which the thanks of the Society were ordered.

February 10, 1684–5.—A Letter from Mr. Aston, dated Feb. 2, was read. It affirm'd (among other things) *That mortar is always without hair*; of ye truth of which we must own our selves not as yet satisfied.

Ordered—That Mr. Maunders, chaplain to Col. Luttrel, in Dorsetshire, Mr. Thomas, minister of Chard, and Dr. Turbervile of Salisbury, be asked what information they can give of ye late cold wind, which proved so fatal in Wiltshire, and Dorsetshire, about last Christmas. Also that Mr. Maunders be desired, as his occasions will give him leave, to draw up, and send us, an account of ye *Laver*, an Herb growing on ye rocks near Dunster Castle.

An account of ye weather here at Oxford, December, January, and February last, taken by Mr. Walker, was by him presented to ye Society.

A letter from Mr. Cuningham, dated St. Leonards College, Jan. 17, 1684–5, written to Mr. President, was read; It shewed his great readiness to procure us correspondents in Scotland; and contained a letter from ye reverend Dr. Skene, Provost of our holy Saviour's College, in St. Andrewes, to Mr. President, concerning ye establishing a Communication of matters Philosophicall, between this Society and ye learned Doctor, and his friends. It was ordered, that some of our Minutes be transcribed, to be sent ye Doctor, with the humble thanks of this Society for his compliance in this matter.

Mr. Standard of Merton communicated the results of his experiments on the weights of the several parts of Hens' eggs, weighed before and after boiling. The weighings were made with a pair of scales which turned with half a grain.

Societies and Academies.

LONDON.

Royal Society, January 29.—P. M. S. **Blackett**: The ejection of protons from nitrogen nuclei, photographed by the Wilson method. Photographs have been taken of more than 400,000 alpha-ray tracks in nitrogen, using an automatic form of the Wilson condensation apparatus. A source of thorium $B+C_1$ was used, giving a mixed beam of 8·6 and 5·0 cm. alpha particles. Among the tracks were found many normal forks due to the elastic collisions between alpha particles and nitrogen nuclei. In addition, eight forks were found of a strikingly different type. These abnormal forks represent the ejection of protons from nitrogen nuclei. Each track branches into two arms, one of which clearly represents the track of the proton. Since there is only one other arm to represent the tracks of both the residual nucleus and the alpha particle itself, the two particles must be bound together after the collision. When, therefore, a proton is ejected from a nitrogen nucleus by a fast alpha particle, the alpha particle itself is captured by the residual nucleus, forming a new nucleus which should have a mass of 17 and an atomic number 8.—R. E. **Gibbs**: The variation with temperature of the intensity of reflection of X-rays from quartz and its bearing on the crystal structure. Whilst the space group to which quartz belongs is known, the positions of the atoms in the molecule remain undetermined. The oxygen atoms cannot lie in the same basal planes as do the silicon, but must interleave them at a distance *d*. Of all the four unknown parameters, the variation of *d* alone will affect the intensity of reflection from the basal plane. Reflection intensities measured from 0° to 800° C. show that marked changes occur for all the planes at the transition point.—R. W. **Gurney**: (1) Ionisation by alpha particles in monatomic and diatomic gases. In the monatomic gases—xenon, krypton, argon, neon, and helium—the amount of ionisation increases with increasing atomic number, a result to be expected from their decreasing ionisation-potentials. In the diatomic gases—hydrogen, oxygen, and nitrogen—ionisation is less than in any of the monatomic gases, in spite of the high value of the ionisation-potential of helium. The ratio of the ionisation in the gases to that in air varies with the velocity of the alpha particles. The question is discussed whether the value (33 volts) found by Geiger for the average expenditure of energy per pair of ions in air is applicable to ionisation near the end of the range. (2) The stopping-power of gases for alpha particles of different velocities. Since the stopping-power of a substance varies with the velocity of the alpha particles traversing it, the value obtained for the stopping-power of a gas by a measurement made over the whole or a large part of the range, as has usually been done, is merely an average value. Small portions of the range are here selected, so that the relative stopping-power has been measured for alpha particles of high velocity, of low velocity, and of intermediate velocity, separately. The relative values of the atomic stopping-powers tend to converge at the end of the range.—W. E. **Curtis**: The Fulcher hydrogen bands. The Fulcher lines and Allen's additions to them have been examined with the view of finding a theoretical interpretation of them. The wave-numbers of two of the strongest lines require correction by about 0·5 $cm.^{-1}$. The differences are then sufficiently regular to provide a criterion for the genuineness of the extra lines, which are in the main confirmed. The arrangement is consistent

with the view that they originate from combinations of simultaneously occurring rotation and vibration changes. New values of the molecular moments of inertia concerned are obtained which probably refer to an "excited" molecule. The nuclear vibrations within the hydrogen molecule seem to be very nearly simple harmonic, which would account, in conjunction with the small moment of inertia, for the unique structure of the system as compared with other band systems. The two sets of Fulcher triplets apparently originate from two molecules essentially similar in structure.—W. L. **Webster**: The magnetic properties of iron crystals. The magnetic properties may be accounted for by the Weiss theory of molecular fields. The magnitude of the molecular field is found for two crystals, giving respectively 620 and 479 gauss. The magnitude of the component along any one of the crystal axes varies as $\cos^4(\psi)$, (ψ) being the angle between the axis and the direction of magnetisation. The molecular field is a stable property of the crystal, and is affected considerably by the presence of impurities.—A. E. **Ingham** and J. E. **Jones**: On the calculation of certain crystal potential constants and on the cubic crystal of least potential energy.—E. C. **Stoner** and L. H. **Martin**: The absorption of X-rays. Two beams, defined by two slit systems, one vertically above the other, are reflected by the same crystal into two ionisation chambers. The beams are first balanced. A sheet of the absorbing material is then placed in the path of the upper beam, and the beams rebalanced by moving a wedge of aluminium across the path of the lower beam. The well-known law $\tau/\rho = \text{const.}\ Z^4\lambda^3$ holds only on the long wave-length side, or sufficiently far away on the short wave-length side of the K absorption discontinuity. Neither the formula of de Broglie nor of Kramers gives correctly the variation of the magnitude of the K group with atomic numbers. Measurements on the absorption co-efficients of uranium on each side of the three L absorption discontinuities show that the number of electrons associated with the L_3 level equals the sum of the numbers associated with the L_1 and L_2 levels. This is in agreement with Dauvillier's result for gold.—F. H. **Schofield**: The thermal and electrical conductivities of some pure metals. The maximum temperature used was 700° C. The thermal conductivity of aluminium increases with rising temperature, that of nickel decreases at first, and then above 500° C. increases. Copper, magnesium, and zinc showed, on the whole, slight decreases of conductivity with temperature. The values of Lorenz's function for copper, magnesium, and zinc were practically constant at all temperatures; that for aluminium showed a rise with increasing temperature; that for nickel showed a rise to 300° C., above which temperature it remained nearly constant except for an abnormal value at 400° C.—M. de **Sélincourt**: On the effect of temperature on the anomalous reflection of silver. The existence of a well-defined band in the ultra-violet (about 40 Å in width) at which the reflection co-efficient of silver is negligible, has been utilised to investigate the relation between the frequency of the free electrons which are responsible for the reflection and the mean distance between the particles of the metal. The point of minimum reflection has been determined by a photographic method at the four temperatures −183°, −79°, 16° and 150°; the band is displaced in the direction of decreasing wave-length as the temperature is lowered, and is at the same time rendered sharper and narrower.—T. L. **Ibbs**: Thermal diffusion measurements. Mixtures of each of the following pairs of gases were used: hydrogen and carbon-dioxide, hydrogen and nitrogen, nitrogen and carbon-dioxide, hydrogen and argon, helium and argon. The apparatus consists essentially of a small cold vessel maintained at uniform temperature, joined by a connecting tube to a larger vessel the temperature of which can be raised as required to about 300° C. Thermal diffusion produces a difference in the distribution of the components of the mixture on the hot and cold sides, and the resulting change in composition on the cold side is measured directly by means of a katharometer, the open cell of which forms part of the cold side. There is a general tendency for the gas with the heavier molecules to diffuse towards the cold side. The total separation is nearly proportional to $\log T_1/T_2$ (where T_1 is the absolute temperature of the hot side, and T_2 the absolute temperature of the cold) in all cases.

Optical Society, December 11.—J. **Guild**: (1) An equipment for visual spectro-photometry. The equipment for visual spectro-photometry designed by the author and installed in the Optics Division of the National Physical Laboratory. The basis of measurement is Talbot's law as applied to rotating sectors. By employing a series of sectors the whole range of effective transmission from 100 per cent. to 0·01 per cent. is covered by a series of fixed points, each of which corresponds to a transmission about 90 per cent. of the next higher, with only a few sectors none of which is below 1 per cent. in its effective transmission. The gaps between the fixed points are covered by photometric wedges calibrated in terms of the sector discs. The field of the instrument is of the Lummer-Brodhun contrast pattern. (2) Transformation of trichromatic mixture data. Algebraic methods of transforming colour mixture equations from one trichromatic system to another are described. Measurements made in terms of the arbitrary working primaries of any trichromatic colorimeter can be transformed into any system of standard primaries or vice versa, without auxiliary measurements other than can be made on the instrument itself used in the normal manner.—L. C. **Martin**: A simple microphotometer. The addition of a few auxiliary parts, including a photometric comparison cube, permits an ordinary microscope to be used for finding the average density over a very small area of a photographic plate by visual methods. The instrument is useful with spectrograms and star images.

January 15.—W. H. **Steavenson**: A peep into Sir William Herschel's workshop. See NATURE, July 5, 1924, p. 21.—P. P. **Schilovsky**: Slow speed precision training gear governed from a distance. The increase in precision in the training of telescopes, microscopes, etc., is possible only if an electrical device, controlled from a distant station, is applied to the moving parts. The angular velocity of the training motor must correspond with that of the handle of the manipulator. Standard motors in which the speed of rotation depends upon load and output cannot be used; the only system available is one where the manipulator can revolve the magnetic field of a motor's element in strict conformity with the speed and direction of a distant device at the governing station.

Aristotelian Society, January 5.—G. Dawes **Hicks**: The dynamic aspect of Nature. The view that "force," in the sense of strain or stress, is a subjective phenomenon is devoid of justification. As it is requisite to distinguish the *perception* of a colour from the *colour*, so it is requisite to distinguish the *perception* or *feeling* of a strain from the *strain* which

we perceive or feel. Though the sun is not *conscious* of a strain when it pulls the earth, it does not in the least follow that in doing so it is not subject to a strain. On the other hand, one may legitimately argue that the " mind " or " self " is as such neither subject to a strain, in the sense in which that term is used of material things, nor to be conceived as putting forth energy. In willing, as indeed in cognising, the " mind " is certainly active, but the activity is not analogous to what is signified by the phrase " exertion of force." Further, there is no ground for the contention that what we are cognisant of as " force " or " energy " is confined to organic phenomena, a supposition which would necessitate a theory of vitalism cruder than any hitherto suggested. The truth rather is that modern physics, with its conception of " lines of force " and its doctrine of energy, presupposes the reality of the factors of stress and strain in the physical world. The concept of either " force " or " energy " as an entity *per se* is doubtless a pseudo-concept; but the notion of mass and energy as inseparably combined would seem to be a necessity for physical theory. The attempt to conceive of energy as the one physical reality and of matter as a derivative therefrom results simply in the materialisation of energy. A quantum of energy becomes to all intents and purposes a materialised body, although matter is supposed to be dispensed with. The paper concluded by criticising certain consequences which have been thought to follow from the general theory of relativity.

Mineralogical Society, January 20.—K. **Yardley**: An X-ray examination of calcium formate. The orthorhombic bipyramidal unit cell contains 8 asymmetric molecules. The dimensions are $a = 10{\cdot}19$ Å, $b = 13{\cdot}41$ Å, $c = 6{\cdot}27$ Å. The structure is founded on the Bravais lattice Γ_0, and belongs to the space-group Q_h^5.—John **Parry** and F. E. **Wright**: Afwillite, a new hydrous calcium silicate from Dutoitspan mine, Kimberley, South Africa. This mineral was found by Mr. A. F. Williams as large water-clear crystals. These are monoclinic. Analyses give the formula $3CaO \cdot 2SiO_2 \cdot 3H_2O$ or $2H_2CaSiO_4 \cdot Ca(OH)_2$. It has a slight alkaline reaction and is completely decomposed by dilute hydrochloric acid. Optical and crystallographic data are given in detail.—P. N. **Chirvinsky**: Tyuyamunite from the Tyuya-Muyun radium mine in Fergana. A review is given of the literature on the copper, vanadium, and uranium ores at this locality. The mineral tyuyamunite, $CaO \cdot 2UO_3 \cdot V_2O_5 \cdot mH_2O$, is related to carnotite, having calcium in place of potassium. The microscopical characters of the minute orthorhombic crystals are described.—L. J. **Spencer**: International agreement in mineralogical and crystallographical nomenclature. With a small amount of " give and take " in different countries much greater uniformity could be attained for mineral names. For international purposes the correct spelling of the printed word is of more importance than the correct pronunciation. There is no necessity to provide well-established mineral-names with the termination *ite*. The Millerian notation for crystal planes is the best for international use. The principal optical directions are conveniently given by α, β, γ, corresponding with the three principal indices of refraction.

EDINBURGH.

Royal Society, January 12.—E. Leonard **Gill**: The Permian fish, Dorypterus. The external covering of Dorypterus consisted only of a series of large scales protecting the belly, of a curious cord-like row of spindle scales and a few scales upon the tail. The bony structures of the few examples which have been preserved, show that it belonged to the coral-fish type, that its body was exceedingly compressed and roughly circular in outline, and that its jaws, differing from those of any other known fish from the earlier deposits, show it to have developed a highly specialised mode of feeding. Its flattened body, comparative lack of scales, and limited amount of muscular tissue, necessitated that exceptional support should be derived from the bony skeleton, and hence the median plane has become filled with a development of bony spines and fin-supports, such as is scarcely equalled in any other fish. In this and other respects it shows general and remarkable convergence of adaptation to modern flattened fishes of the " John Dory " type, while in the placing of its paired fins its aspect is also modern. The investigation demands the formation of a new family for " Dorypterus," and a readjustment of its recognised place in the scale of fish evolution.—E. A. **Baker**: The law of blackening of the photographic plate at low densities. This investigation was undertaken at the Royal Observatory, Edinburgh, in order to supply the necessary physical data for a photometric study of stellar spectra. Such a study leads to the characteristic curve of radiative intensity of each star, and the determination of its temperature. But a prerequisite is the conversion from density on the photographic plate to the intensity of the illumination, for any wave-length. The instrument for measuring density is a photometer, constructed by the author, on the principle devised by Koch, in which the obscured and unobscured beams pass to two photo-electric cells and their effects are balanced against one another. The production of standard deposits representing definite ratios of the incident light was effected by means of screens pierced by standard apertures, registering upon the same spot and exposed separately or together. The values for different wave-lengths were secured by suitable colour filters. These are at present confined to the violet and the red, the filters not being sufficiently selective in the green. The results are expressed in the form of the determination of certain coefficients, equivalent to, and superseding the current statements of the inertia of the plate, development constant, and the departure from reciprocity indicated by Schwarzschild's index.—E. L. **Ince**: The vibrations of a stretched membrane with a particular law of density. Membranes the density of which diminishes according to the square of the distance from a fixed point were considered. The boundary is either circular, elliptical, or rectangular. For particular values of the constants the problem is simpler than in the case of uniform density. These simple cases are considered, and the problem is then dealt with more generally by an appeal to the Sturmian theory of differential equations.

VIENNA.

Academy of Sciences, November 20.—J. **Kaess**: Fermat's great theorem and its solution.—A. **Rollett** and A. **Schmitt**: On β-amyrin from Manila elemi-resin (third contribution).—K. **Stosius** and E. **Philippi**: The course of the action of ammonia on cinnamic acid ethyl ester.—M. **Nicolic**: The influence of light on the germination of *Phacelia tanacetifolia*. The germinating power of the seeds is in part completely destroyed, in part hindered, by continued illumination. The retarding action of light increases with the strength of the illumination.—F. **Dormann**:

The epidermal glands and excretion of resin in *Alnus viridis*.

November 27.—The vice-president announced the death of Sir Archibald Geikie, honorary member of the Academy.—S. **Meyer**: Communications of the Radium Institute, No. 171. Coefficients of atomic magnetism for the rare earths. New determinations with the purest material from C. Auer-Welsbach and for hafnium from G. Hevesy. Cassiopeium and hafnium are as diamagnetic as lanthanum and zirconium. Tetravalent præsodymium has nearly the same atomic magnetism as trivalent cerium, and tetravalent cerium nearly the same as trivalent lanthanum. The results are important for the co-ordination of electronic orbits in Bohr's atomic model.—J. **Kaess**: Construction of the angle 1° with compasses and ruler.—G. **Weissenberger**, F. **Schuster**, and N. **Mayer**: On the molecular compounds of the phenols, VI. The behaviour of naphthols, tetrahydronaphthol, and allied compounds.

December 4.—H. **Pettersson**: Communication of the Radium Institute, No. 172. The field of force of the atomic nucleus and Coulomb's law. Experiments seem to show that α-particles shot at the nucleus of certain elements are not reflected but remain at the nucleus. This, as well as the results obtained by Bieler, can be explained by considering the electrostatic induction between α-particle and nucleus on the basis of Coulomb's law.—J. **Kaess**: Division of a circle into 7 and into 9 parts by ruler and compasses.—L. **Holzer**: Estimation of the units in a cubic number-body (Zahlkörper).—F. **Raas**: The crystal form of the orthoclases. The growth velocities of single crystal surfaces are given numerically as relative central distances.—R. **Mueller**, E. **Pinter**, and K. **Prett**: The electrochemistry of non-aqueous solutions, Communication VI. Experiments on the electrolytic deposition of some metals from solutions in amyl alcohol, acetonitrile, aniline, and chinoline.—B. **Guth**: On the chemistry of the higher fungi, Communication XVIII. Investigations on the muscarine problem.—J. **Zellner**: On the chemistry of heterotrophic phanerogams, Communication V. The parasite *Prosopanche Burmeisteri* contains special tannoids.—J. **Pia**: Remains of a land plant in the Noetsch coal strata in the eastern Gailtal Alps. A new fern, Gymnoneuropteris.

Official Publications Received.

United States Department of Agriculture. Department Bulletin No. 1235: Life History of the Codling Moth in the Yakima Valley of Washington. By E. J. Newcomer and W. D. Whitcomb. Pp. 77+3 plates. (Washington: Government Printing Office.) 15 cents.

Department of the Interior: Bureau of Education. Bulletin, 1924, No. 26: Statistics of State Universities and State Colleges for Year ending June 30, 1923. Prepared under the Supervision of Frank M. Phillips. Pp. 15. (Washington: Government Printing Office.) 5 cents.

Chemistry in the Service of the State. Pp. 31. (Madison, Wis.: Department of Chemistry, University of Wisconsin.)

Dove Marine Laboratory, Cullercoats, Northumberland. Report for the Year ending June 30th, 1924. Edited by Prof. Alexander Meek. Pp. 121. (Cullercoats.) 5*s*.

Proposed National Institute for Research in Colloid Chemistry. The Need for such an Institute, the Plan for its Operation, an Argument for its Location, Letters of Commendation. Pp. 104. (Madison, Wis.: University of Wisconsin.)

University of Birmingham: Executive Board of Mining Research. Report on the Work of the Mining Research Laboratory, 1921–1924. Pp. 32. (Birmingham.)

Scientific Papers of the Institute of Physical and Chemical Research. Vol. 1, No. 12, March: Spectra of Constricted Arc of Metals. By Toshio Takamine and Mitsuharu Fukuda. Pp. 207-216+plates 5-8. 45 sen. Vol. 1, No. 13, August: The Fine Structure of Mercury Lines and the Isotopes. By Hantaro Nagaoka, Voshikatsu Suguira, and Tadao Mishima. Pp. 217-258+plates 9-18. 2 yen. (Tokyo: Institute of Physical and Chemical Research, Komagome, Hongo.)

Department of Agriculture. Science Bulletin No. 33: Report on the Cost of Production of Maize Investigation for the Season 1921–22. By E. Parrish. Pp. 46. (Pretoria: Government Printing and Stationery Office.) 6*d*.

The Marine Biological Station at Port Erin (Isle of Man), being the Thirty-eighth 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. 47. (Liverpool: University Press of Liverpool, Ltd.; London: Hodder and Stoughton, Ltd.) 1*s*. 6*d*. net.

The Botanical Society and Exchange Club of the British Isles. Vol. 7, Part 1: Report for 1923. By G. Claridge Bruce. Pp. 366+6 plates. (Arbroath: T. Buncle and Co.) 10*s*.

Osmania University, Hyderabad: Publications of the Nizamiah Observatory. Astrographic Catalogue 1900·0, Hyderabad Section, (Part 2). Dec. −20° to −24°, from Photographs taken and measured at the Nizamiah Observatory, Hyderabad, under the Direction of T. P. Bhaskaran. Vol. 5: Measures of Rectangular Co-ordinates and Diameters of 88,444 Star-images on Plates with Centres in Dec. −21°. Pp. xxxix+290. (Nizamiah: Osmania University.) 15 rupees; 20*s*. net.

Trinidad and Tobago. Council Paper No. 105 of 1924. Agricultural Credit Societies: Report by the Registrar of Agricultural Credit Societies for the Year ended 30th June, 1924. Pp. 8. (Port-of-Spain.) 4*d*.

Bulletin of the American Museum of Natural History. Vol. 51, Art. 7: The Pectoral Limb of *Eryops* and other Primitive Tetrapods. By Roy Waldo Miner. Pp. 145-312. (New York.)

Department of the Interior: Bureau of Education. Bulletin, 1923, No. 55: Bibliography of Educational and Psychological Tests and Measurements. Compiled by Margaret Doherty and Josephine MacLatchy under the Direction of B. R. Buckingham. Pp. ix+233. (Washington: Government Printing Office.) 25 cents.

Fifty-fifth Annual Report of the Trustees of the American Museum of Natural History for the Year 1923. Pp. xxiv+269+13 plates. (New York City.)

Conseil Permanent International pour l'Exploration de la Mer. Rapports et procès-verbaux des réunions. Vol. 35: Rapport Atlantique 1923 (Travaux du Comité du Plateau Continental Atlantique) (Atlantic Slope Committee). Publié avec l'aide de Dr. Ed. Le Danois. Pp. 58+11 planches. (Copenhague: Andr. Fred. Høst et fils.)

Methods and Problems of Medical Education. (Second Series.) Pp. 11+118. (New York: The Rockefeller Foundation.)

Diary of Societies.

SATURDAY, FEBRUARY 7.

ROYAL SOCIETY OF MEDICINE (Otology Section), at 10.30 A.M.—L. Colledge: Demonstration of Kinematograph Pictures of Cases of Facial Paralysis treated by Nerve Anastomosis.—G. J. Jenkins: Septicæmia as a Complication of Middle-ear Infection.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. E. H. Fellowes: The Elizabethan Ayre.

GILBERT WHITE FELLOWSHIP (at 6 Queen Square, W.C.), at 3.—Dr. J. R. Leeson: The Evolution of Man.

INSTITUTE OF BRITISH FOUNDRYMEN (Lancashire Branch) (at Grand Hotel, Manchester), at 4.—V. C. Faulkner: A Psychological Examination of Foundry Life.

HULL ASSOCIATION OF ENGINEERS (at Hull Municipal Technical College), at 7.15.—J. Sim: Recent Developments in Marine Auxiliaries.

MONDAY, FEBRUARY 9.

ROYAL IRISH ACADEMY (at Dublin), at 4.15.

ROYAL SOCIETY OF EDINBURGH, at 4.30.—W. L. Calderwood: The Relation of Sea Growth to the Spawning Frequency in *Salmo salar*.—Prof. F. J. Cole: A Monograph on the General Morphology of the Myxinoid Fishes based on a study of Myxine. Pt. 6: The Blood Vascular and Lymphatic Systems.—Sir Thomas Muir: The Theory of Compound Determinants from 1900 to 1920.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Prof. A. T. Clay: The Amaru.

BIOCHEMICAL SOCIETY (in Biochemical Department, University College), at 5.—H. J. Channon: Cholesterol Synthesis in the Animal Body.—G. A. Harrison and H. J. Channon: Observations on the Composition of Subcutaneous Fat in Cases of Sclerema Neonatorum.—C. R. Harington: 3:4:5 Tri-iodophenyl-pyrollidone-carboxylic Acid.—J. C. Drummond and K. H. Coward: (*a*) Further Observations on the Chemical Nature of the Vitamin Fraction of Cod Liver Oil; (*b*) Ultra-violet Radiation and Growth.—S. Tsubura: Comparison of the Reducing Properties of Plain and Striated Muscle.—Dr. P. Haas and T. G. Hill: An Oxygen Absorbing Mechanism in *Mercurialis perennis* and Accompanying Colour Changes.—A. Wormall: The Tyrosinase-tyrosine Reaction: the Theory of Deamination.—F. C. Happold and H. S. Raper: The Supposed Deaminising Action of Tyrosinase on Amino Acids.—C. Rimington and H. D. Kay: The Phosphorus of Caseinogen (Preliminary Communication).

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. V. E. Negus: Some Disorders of the Larynx.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—Capt. P. P. Eckersley and others: Discussion on Broadcasting.

INSTITUTION OF MECHANICAL ENGINEERS (Graduates Section), at 7.—K. Rowell: Recent Developments in Solid Injection Oil Engines.

INSTITUTE OF METALS (Scottish Local Section) (at 39 Elmbank Crescent, Glasgow), at 7.30.—J. A. Gardner: Methods of Keeping Foundry Records.

ROYAL SOCIETY OF MEDICINE (Epidemiology and State Medicine, Comparative Medicine, Disease in Children Sections), at 8.—Dr. Robertson, Dr. Niven, and others: Special Discussion on The Control of Tuberculosis and the Milk Supply.

SURVEYORS' INSTITUTION, at 8.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—J. M. de Navarro: Ancient Trade Routes in Europe.

MEDICAL SOCIETY OF LONDON (at 11 Chandos Street, W.), at 8.30.—Sir Thomas Horder, Bart., and others: Discussion on the Treatment of Lymphadenoma.

TUESDAY, FEBRUARY 10.

ROYAL SOCIETY OF MEDICINE (Therapeutics and Pharmacology Section) (at National Institute for Medical Research), at 4.30.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. J. Barcroft: The Colour of the Animal Creation (I.): The Colour of Man.

ROYAL SANITARY INSTITUTE, at 6.—Maj.-Gen. Sir Wilfred Beveridge, Dr. W. M. Willoughby, and others: Discussion on Food and Health.

INSTITUTE OF MARINE ENGINEERS, at 6.30.—Presidential Address.

INSTITUTION OF ELECTRICAL ENGINEERS (East Midland Sub-Centre) (at the College, Loughborough), at 6.45.—S. Ferguson: A General Survey of the High-Tension Switchgear Field.

INSTITUTION OF AUTOMOBILE ENGINEERS (at Royal Society of Arts), at 7.—F. G. Woollard: British Methods of Continuous Production.

INSTITUTION OF ELECTRICAL ENGINEERS (North Midland Centre) (at Hotel Metropole, Leeds), at 7.—Informal Discussion on Domestic Electrical Apparatus.

ROYAL PHOTOGRAPHIC SOCIETY (Scientific and Technical Group), at 7.—Conference on the Standardisation of Plate Testing Methods:—Section IV. The Measurement of Photographic Densities: (*a*) Survey of the Present Position; (*b*) Standardisation of Photographic Densities; (*c*) Methods of Measurement. Opening Paper by Dr. C. F. Toy.—Section V. The Interpretation of Results: (*a*) Plate Speeds. The Hurter and Driffield and other Systems; (*b*) Inadequacy of these Systems. Rôle played by the under, correct and over exposure portions of the plate curve. Opening Paper by T. Thorne Baker and O. Bloch.

INSTITUTION OF AUTOMOBILE ENGINEERS (Coventry Graduates Meeting) (at Broadgate Café, Coventry), at 7.15.—G. H. Day: Aluminium: its Alloys and their Use in the Automobile Industry.

INSTITUTION OF ELECTRICAL ENGINEERS (Scottish Section) (at 207 Bath Street, Glasgow), at 7.30.—H. W. Taylor: Three-wire Direct-current Distribution Networks: Some Comparisons in Cost and Operation.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND (at 39 Elmbank Crescent, Glasgow), at 7.30.

QUEKETT MICROSCOPICAL CLUB, at 7.30.—D. J. Scourfield: Asymmetry among Microscopic Organisms (Presidential Address).

INSTITUTION OF MECHANICAL ENGINEERS (Swansea Meeting).

WEDNESDAY, FEBRUARY 11.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS (at Old Colony Club, Aldwych House, W.C.) (Annual General Meeting), at 2.30.—A. H. Barker: Unsettled Questions in Heating and Ventilation.

ROYAL SOCIETY OF ARTS, at 4.30.—Sir J. Fortescue Flannery, Bart.: The Diesel Engine in Navigation.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. R. L. Knaggs: Osteitis Deformans, and its relation to Osteitis Fibrosa and Osteomalacia.

BRITISH SOCIETY OF MASTER GLASS-PAINTERS (at 6 Queen Square, W.C.), at 6.—W. E. Tower: The 14th Century Glass of Tewkesbury and its Recent Repair.

SOCIETY OF CHEMICAL INDUSTRY (Glasgow Section, jointly with the Glasgow University Alchemists' Club and Institute of Chemistry) (at Glasgow University), at 7.—R. B. Pilcher: Alchemists and Chemists in Art and Literature.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Graduate Section) (at Bolbec Hall, Newcastle-on-Tyne), at 7.—F. H. Todd: The Capital Ship as affected by the Washington Conference.

INSTITUTION OF AUTOMOBILE ENGINEERS (Wolverhampton Centre) (at Wolverhampton), at 7.30.—F. G. Woollard: British Methods of Continuous Production.

INSTITUTION OF CHEMICAL ENGINEERS (jointly with the Chemical Engineering Group of the Society of Chemical Industry) (at Institution of Mechanical Engineers), at 7.30.—O. Brünler: Internal Combustion Boilers.—D. Brownlie: Steam Generation under Critical Conditions.

EUGENICS EDUCATION SOCIETY (at Royal Society), at 8.30.—Dr. B. Malinowski: Mate Selection in Primitive Society.

THURSDAY, FEBRUARY 12.

ROYAL SOCIETY, at 4.30.—H. Muir Evans: A Contribution to the Anatomy and Physiology of the Air Bladder and Weberian Ossicles in Cyprinidæ.—J. S. Huxley: Studies on Amphibian Metamorphosis, II.—*To be read in title only:*—Prof. A. Dendy: An Orthogenetic Series of Growth Forms in certain Tetraxonid Sponge-Spicules.—Dr. C. E. Walker: The Meiotic Phase in Triton (*Molge vulgaris*).—W. E. Alkins: *Clausilia bidentata* (Ström) and *Cl. cravenensis* (Taylor): A Statistical Enquiry into the Relationship of two Similar Species.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Sir William Bragg: The Properties and Structure of Quartz (III.).

ROYAL AERONAUTICAL SOCIETY, at 5.30.—Col. F. Searle: The Maintenance of Commercial Aircraft.

ROYAL SOCIETY OF MEDICINE (Tropical Diseases and Parasitology Sections), at 5.30.—Dr. A. F. MacCallan: Ophthalmology in Egypt.—Capt. W. H. Dye: Schistosomiasis and Splenomegaly in Nyasaland.

INSTITUTE OF MARINE ENGINEERS, at 6.30.

SOCIETY OF CHEMICAL INDUSTRY (Birmingham and Midland Section) (at Birmingham University), at 7.15.—Dr. J. Newton Friend: Iron in Antiquity.

INSTITUTION OF ELECTRICAL ENGINEERS (Dundee Sub-Centre) (at University College, Dundee), at 7.30.—Prof. A. R. Fulton: The Utilisation of Tides for the Production of Power.

INSTITUTION OF ELECTRICAL ENGINEERS (Irish Centre) (at Trinity College, Dublin), at 7.45.—J. H. Shaw: The Services of the Electrical Engineer in the Post Office.

OPTICAL SOCIETY (at Imperial College of Science and Technology), at 8.—Annual General Meeting.—Dr. A. Barr: Presidential Address.

OIL AND COLOUR CHEMISTS' ASSOCIATION (at 8 St. Martin's Place, W.C.), at 8.—A. A. Drummon: Synthetic Resins.—R. G. Browning: The Painting of Ships.

SOCIETY OF DYERS AND COLOURISTS (Bradford Junior Branch) (at Bradford).—W. White: Wool Printing.

FRIDAY, FEBRUARY 13.

DIESEL ENGINE USERS' ASSOCIATION (at Engineers' Club, Coventry Street), at 3.30.—P. A. Holliday: Submarine Engines and High-speed Heavy-oil Engine Electric Generating Sets.

ROYAL DUBLIN SOCIETY, at 4.30.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Annual General Meeting.—Prof. Eddington, Dr. Jackson, Mrs. Maunder, and Prof. Milne: The Progress of Astronomy.—Prof. Fowler and Prof. Newall: The Meeting at Cambridge of the International Astronomical Union.—Dr. Dreyer: Tycho Brahe's Observations, Methods, and Results.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 5.—Annual General Meeting.—F. E. Smith: A System of Electrical Measurements (Presidential Address).

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. S. Cade: Regional Anæsthesia.

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.—Discussion on Gear Production Machinery.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—M. Adams: Concerning Children and Photography.

INSTITUTE OF METALS (Swansea Local Section) (at Swansea University College), at 7.15.—Dr. H. Moore: Season Cracking and its Prevention.

SOCIETY OF CHEMICAL INDUSTRY (South Wales Section) (at Technical College, Swansea), at 7.30.—C. A. Seyler: Microscopic Structure of Coals.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—L. Pendred: Milestones in the Development of the Prime-mover Locomotive.

INSTITUTE OF METALS (Sheffield Local Section, jointly with the Sheffield Metallurgical Association and other Societies) (at 198 West Street, Sheffield), at 7.30.—Dr. C. H. Lander: Fuel and its Efficient Utilisation.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at Literary and Philosophical Society, Newcastle-on-Tyne), at 7.30.—J. W. Hobson: The Internal-combustion Locomotive.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Dr. B. Malinowski: The Forces of Law and Order in a Primitive Community.

SOCIETY OF DYERS AND COLOURISTS (Scottish Section).—I. E. Weber: Hydrogen Peroxide and Bleaching.

SOCIETY OF DYERS AND COLOURISTS (Manchester Junior Branch) (at Manchester).—K. H. Saunders: A Paper.

INSTITUTION OF MECHANICAL ENGINEERS (Leeds Meeting).

SATURDAY, FEBRUARY 14.

ROYAL INSTITUTION, at 3.—W. Rothenstein: The Artist's Relation to Social and Religious Life (I.).

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 4.—Sir D'Arcy Power: Hunterian Oration.

INSTITUTE OF METALS (London Local Section) (at Institute of Marine Engineers), at 7.30.—V. C. Faulkner: Some Notes on Refractory Materials.

PUBLIC LECTURES.

SATURDAY, FEBRUARY 7.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—R. P. G. Denman: The Development of Modern Radio Communication.

MONDAY, FEBRUARY 9.

LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE, at 5.—Dr. E. B. Behrens: International Labour Organisation.

BIRKBECK COLLEGE, at 5.30.—Dr. G. G. Coulton: Chapters in Medieval Education (II.). Song and Grammar Schools.

KING'S COLLEGE, at 5.30.—S. Smith: The Nature and Influence of Babylonian Literature.

UNIVERSITY COLLEGE, at 5.30.—Lt.-Commdr. E. Sutton: Buddhism. (Succeeding Lecture on February 16.)

TUESDAY, FEBRUARY 10.

KING'S COLLEGE, at 5.30.—Dr. E. Bevan: The Hebrew and Greek Idea of God with special reference to Philo of Alexandria.

UNIVERSITY COLLEGE, at 5.30.—Dr. C. F. Sonntag: Man's Place in Nature (I.). (Succeeding Lecture on February 24.)

SIR JOHN CASS TECHNICAL INSTITUTE, at 8.—S. O. Nevile: The Fermentation Industries.

UNIVERSITY OF LEEDS, at 8.—Dr. W. H. Pearsall: Age and Development of Moorland Peat.

WEDNESDAY, FEBRUARY 11.

ST. BARTHOLOMEW'S HOSPITAL MEDICAL COLLEGE (Physiology Department) (6 Giltspur Street, E.C.), at 5.—Dr. J. M. Duncan Scott: The Medullary Centres (I.). (Succeeding Lectures on February 18, 25, March 4.)

LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE, at 5.—J. Adams: The Principles of Design as applied to Pots and Pans.

KING'S COLLEGE, at 5.30.—Sir Thomas Arnold: Arab Travellers and Merchants, A.D. 1000–1500.

THURSDAY, FEBRUARY 12.

KING'S COLLEGE, at 5.30.—Prof. W. E. Soothill: China's Contribution to Western Civilisation.

CENTRAL LIBRARY, 598 Fulham Road, at 8.—W. P. Westell: Regional Survey.

FRIDAY, FEBRUARY 13.

KING'S COLLEGE, at 5.30.—Prof. E. Prestage: Vasco da Gama and the Discovery of the Sea Route to India.

SATURDAY, FEBRUARY 14.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—B. Lovett: Natural History in Folk-lore.