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CONTENTS.

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Twentieth-Century Universities of England.

"ENGLAND, which till lately has had but two universities in the proper sense of the word, will have a dozen, and perhaps the United Kingdom will have a score." So prophesied Sir John Seeley in 1887. By 1909 this forecast had been proved approximately correct : the realisation of projects now pending for raising the University Colleges of Nottingham and Reading to the status of full universities would complete its fulfilment exactly. At present England has ten universities, all of which, except Oxford, Cambridge, and London, were constituted in the first ten years of this century—thirty years after the decade (1871–81) within which were founded nearly all the colleges in which they had their origin.

The first year of the twentieth century saw the granting of a charter to the University of Birmingham (the pioneer in England of the unitary teaching or "single college" type) as the result of zealous and persistent efforts on the part of a group of progressive educational politicians under the leadership of Mr. Joseph Chamberlain. In 1903 the Universities of Manchester and Liverpool, and in 1904, Leeds, received their charters, superseding the charter of 1880 by which the Victoria University was founded as a federal institution. Ten years later, Lord Haldane said of the Order in Council consenting to the charters for Manchester and Liverpool: "The date of this order is, I think, a memorable one. It gave State recognition to a new policy. . . . The principle was accepted that the number of the English Universities was to be increased, and their headquarters were to be in cities." Next came the University of Sheffield, in 1905. In 1908 a charter was granted under which the University of Durham, founded in 1832 under ecclesiastical auspices, was reconstituted as a federal university, with a Newcastle division consisting of the College of Medicine and Armstrong College. The youngest of this family of seven is Bristol, which received its charter in 1909.

This remarkable activity in university-making is attributable in no small measure, as Prof. Newton has lately pointed out,[1] to the discussions which preceded the reconstitution in 1900 of the University of London, consolidating, as they did, public opinion as to what a modern university should be, and stimulating the desire of the provincial university colleges to achieve full autonomy. Dr. A. C. Headlam's interpretation of this opinion may be usefully compared with Seeley's pronouncement a generation before. "A University," wrote Dr. Headlam in "Universities and the Empire," "ought to be an autonomous self-governing corporation, with a constitution of such a character that the influence of broad-minded learning may be supreme.

[1] "The Universities and Educational Systems of the Empire" (Collins, 1924).

Its aim should be *the creation of intellectual life* and the promotion of the highest form of teaching, side by side with original research and investigation." Seeley, in the course of an address delivered in the Town Hall, Birmingham, in 1887, said: "Modern civilisation needs a vast quantity of science: the demand for trustworthy knowledge, scientific, sanitary, technical, economical, political, historical, moral and religious, rises with urgency from these great towns. . . . It is a demand for knowledge, not for training. It is not made in the interest of the young. It calls for institutions by which the whole science of the age may be brought within the reach of all, young and old alike; in short, it calls not for new schools or new colleges in the Oxford and Cambridge sense, but, in the strictest sense of the word, for new universities." Generous as were Seeley's aspirations, the italicised words in the quotation from Dr. Headlam (not italicised in the original) indicate a notable advance since Seeley's day in current conceptions of the functions of a university. We can now say that the discovery of new knowledge and the extension of intellectual fields which follows from it, are an essential part of university life in all departments.

If one looks back to the circumstances of the foundation of the colleges in which the twentieth-century universities originated, one is struck by the fact that they began in most cases as science colleges. Armstrong College, Newcastle-on-Tyne (incorporated in the University of Durham in 1908), was founded in 1871 as the Durham College of Physical Science. Yorkshire College, destined thirty years later to become the University of Leeds, was established as a College of Science in 1874. University College, Bristol, began as a College of Arts in 1876, but the Merchant Venturers' Technical College was associated with it in 1876, and rapidly developed. In 1879 and the following year respectively were founded, as Science Colleges, Firth College, Sheffield, and Mason College, Birmingham. Lastly, in 1881, University College, Nottingham, was opened as a science college, and University College, Liverpool, obtained its charter.

Of the various movements and events which contributed to the establishment of these University Colleges in such rapid succession, and gave them so marked a bias on the side of science and technology, much was said in the course of the jubilee celebrations which took place at the University of Leeds last week. Among them may be mentioned: the Mechanics' Institutes movement, which attempted to stimulate and satisfy the desire of industrial workers for a knowledge of the great discoveries of science, the progress of these discoveries and the rapid development of their applications to industry, the consequent inadequacy of the apprenticeship system of training engineers; the Women's Emancipation movement; the University Extension movement, the Exhibition of 1851 and, perhaps still more, the Paris Exhibition of 1867; the Elementary Education Act of 1870; the Schools Enquiry Commission, and the Royal Commissions on the Universities of Oxford and Cambridge. One of the most powerful of the motives influencing leaders of public opinion at the time was that of providing scientific teaching for students in manufacturing towns, in order to enable England "to maintain her position as the manufacturing centre of the world."

We should be sorry, however, to suggest that the claims of science in education must be presented to an educated community purely on utilitarian grounds. Few scientific workers would now advance that view, and most would agree that in university work the spirit of research should be that of the pursuit of knowledge for its own sake rather than for the profit to be gained from it. The principles upon which the chief modern industries are founded, and the elements used for various purposes in manufacture, were almost all first discovered by investigators working in university and other laboratories without any motive of industrial application before them. It is remarkable to note, for example, that not a single chemical element has ever been discovered in an industrial laboratory, and that the rare elements which are now of such importance in modern developments would never have been thought worth consideration as a means of making profit in a manufacturing works.

Lord Balfour referred very definitely to these aspects of science in a university in an eloquent speech on December 15 at Leeds in connexion with the university celebrations there. "Science itself," he said, "cannot be pursued effectively in the spirit of wealth acquisition. To have applied science you must have pure science, and you will never get pure science to be what it might be, or knowledge really furthered effectively, until those who try to further it are animated in the main, not by material gains, but by the joy of augmenting knowledge itself."

With a right balance maintained between pure and applied science at universities, there must also be something beyond mere technical efficiency in either, namely, regard for the humanistic aspects of all studies. The new humanism of modern science should not permit itself to be strangled by the cordage of over-specialisation as has been the old humanism of classical learning; and if scientific studies are to exert their full influence upon our generation, students of them must be more than experts in their particular subjects—they must be human and social as well. Where this spirit is combined with rich knowledge and the desire to increase it, university training represents intellectual life at its highest and best.

"Elephants in American Art."

Elephants and Ethnologists. By G. Elliot Smith. Pp. viii + 135 + 52 plates. (London: Kegan Paul and Co., Ltd.; New York: E. P. Dutton and Co., 1924.) 15*s.* net.

IN the book which is before us Prof. Elliot Smith has reverted to a subject upon which he enlarged in NATURE some years ago (1915–16). By bringing together under one cover the full evidence upon which he relies in his argument, he has endeavoured once for all to dispose of what he calls the "stereotyped form of criticism," and finally to defeat those who do not endorse his views as to the Asiatic origin of certain items in the culture of Central America. He has succeeded in producing a readable and interesting treatise which is focussed upon a special feature in the art of Copan, and he offers this confidently as a test case in support of his major and more generalised theory. His argument is developed with skill, and he uses all his power as an advocate. But his handling of a much-debated and still debatable problem is, unfortunately, marred by frequent reliance upon dogmatic assertion. The Bellman's axiom, "What I say three times is true," may serve to limit discussion during a Snark-hunting expedition, but is unlikely to be accepted as finally convincing in scientific debate, and serves rather to stimulate than to allay criticism. Prof. Elliot Smith's doctrine would have gained strength, and possibly adherents, had he urged it less aggressively and devoted himself to the elimination of inconsistencies and to the more careful analysis of the evidence upon which he relies. His constant assertion that the case is proved, seems to suggest that further argument is needless. In spite of that, after reading carefully his in many ways able "discussion on one sharply defined issue," one still feels that scientific proof of the main hypothesis is yet to be found and that the problem remains unsolved.

The main discussion centres upon certain zoomorphic designs carved in relief upon the famous "Stela B" at Copan in Honduras, designs which Prof. Elliot Smith asserts represent the heads of Indian elephants, and cannot reasonably be mistaken for anything else (Fig. 1). Others have urged that these conventionalised animal themes have been derived from earlier attempts to represent *indigenous* faunal types, *e.g.* the macaw, the tapir, etc.; while, quite recently, Dr. H. O. Forbes has forcibly urged that the animal fancifully rendered is a cephalopod of some sort, possibly modified through fusion of this *motif* with the macaw theme.

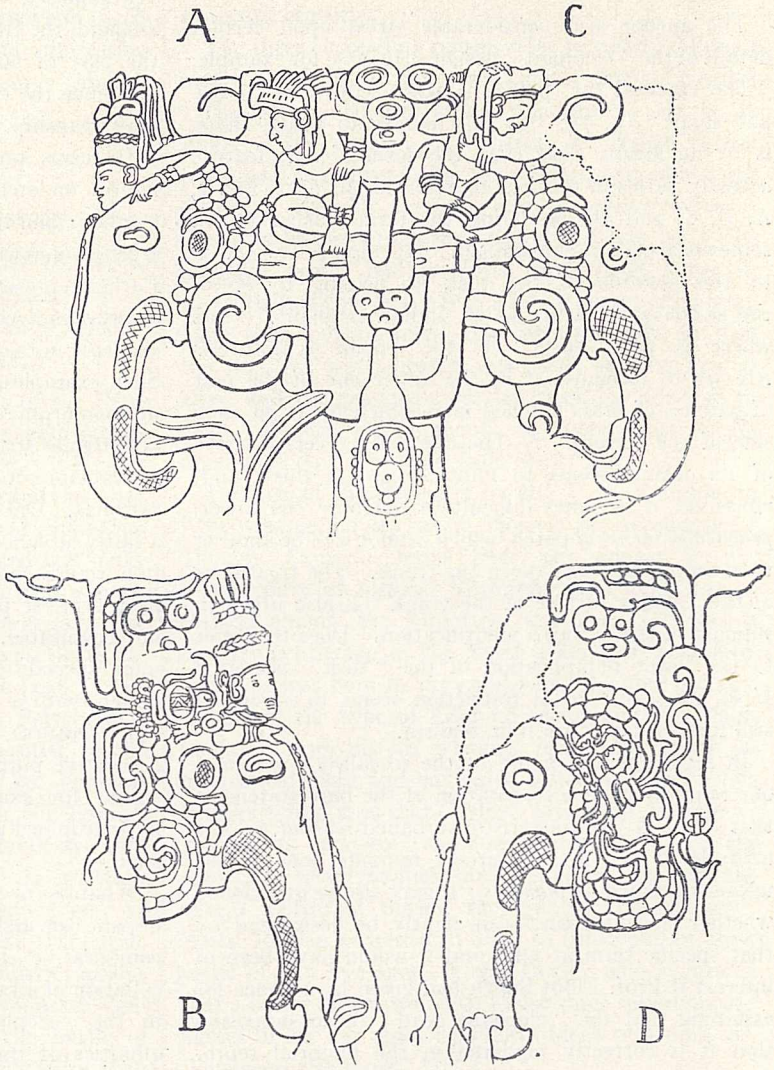

FIG. 1.—Zoomorphic designs sculptured on "Stela B," Copan, Honduras. (After Maudslay.) From "Elephants and Ethnologists."

To Prof. Elliot Smith the design in question represents an "unmistakable Indian elephant ridden by an equally characteristic turbaned *mahout*" (p. 5). This being stated as a fact should end the discussion; but several points of importance call for further inquiry. Prof. Elliot Smith himself allows that the artist, in his attempt to portray an "elephant," was "unacquainted with the features of a living elephant" and "has mistaken its eye for the nostril and its ear for the

eye"; and he endeavours to explain away certain other features which are inconsistent with realistic rendering; and further (p. 112) he refers to "the remarkable modifications effected in the form of the creature when the conventionalised picture is transferred to regions where the animal itself is unknown." And yet, on p. 89, in referring to the Copan "elephants," he indulges in the description "so exact a representation of an animal . . ."—a palpable overstatement.

The author lays considerable stress upon certain details of the "elephant" design. He says, for example, "The external ear (pinna) is also accurate as to size and shape" (p. 7); but this fidelity to actual shape is by no means clear, and the form of this feature actually varies in the four representations of it (Fig. 1, A, B, C, and D), rendering the term "accurate" a somewhat elastic euphemism. He also refers (p. 7) to the position of the tusk as helping to reveal the animal's "identity as an Indian elephant." But where is the "tusk" in the Copan sculptures? Are we to recognise it in the upper one of the pair of patches of cross-hatched lines which occur on each side of the "trunk"? The markedly reversed curve of its outline seems to militate against this; and, moreover, it becomes difficult to diagnose the lower, *practically identical* patch, which cannot well be another tusk arising half-way down the trunk. The treatment of the "under surface of the trunk" is also urged in support of the author's identification. Does this refer to the lower reduplication of the "tusk" pattern? If so, its severe zonal restriction seems to involve a still further departure from realism.

In regard to the figure of the so-called "*mahout*," one requires some corroboration of the bare statement that this is a "characteristic turbaned *mahout*." The attitude of the figure scarcely reminds one of that usually assumed by *mahouts*; it may also be questioned whether the "turban" can rightly be designated by that specific term at all; and it would have been of interest if Prof. Elliot Smith had given his reasons for assuming that the "elephant goad" (even supposing that it is correctly rendered in the pictorial reproductions of the stela) bears any real resemblance to known forms of that instrument (Fig. 1, B).

On p. 27, in his criticism of Maudslay's suggestion that the animal represented is probably a tapir (a beast with which the Maya people were familiar), Prof. Elliot Smith says, "Nor again is it credible that a craftsman so highly skilled in modelling (as the artist who fashioned this stela must have been) could have made so indifferent a portrait of a tapir as this." But it must be borne in mind that this craftsman's skill was largely applied to the production of a decorative and symbolic design, and that when symbolism is subjected to decorative embellishment, there is no limit to the conventionalisation of even a perfectly *well-known* animal form. The treatment in art of the Rhinoceros Hornbill in Borneo, and of the Wreathed Hornbill in New Ireland, affords good examples of grotesque and unrealistic elaboration of familiar bird-forms; while the zoomorphic designs in the composite totemistic art of N.W. America, or the highly conventionalised renderings of the human form in New Zealand, the Hawaiian Islands, and elsewhere, illustrate the play of fancy in what might have been realistic art, since the true forms were familiar enough and the craftsmanship was of a high order.

It seems probable that the so-called "elephant" figures on stela B are designs which are not only symbolic and decorative, but have been arrived at by a fusion of attributes derived from different prototypes. Earlier representations of macaws, cephalopods, tapirs, or other indigenous animals may well have contributed elements in the evolution of this complex hybrid design. Such examples of composite themes are very frequent in zoomorphic and other art designs, and the results are often as striking and unexpected as is the superficial resemblance to an elephant noticed in the Copan carvings. Once the departure from realism has reached a fairly advanced stage, the process of conventionalisation would tend to become accelerated, and the original prototype or prototypes may rapidly become almost unrecognisable. Moreover, the great exaggeration of some special feature in a once more or less realistic design, with a correlated diminution and obscuring of other features, is a common result of elaboration for decorative purposes. The semblance of an elephant's trunk, for example, might easily arise from some hypertrophied portion of a totally different zoomorphic *motif*.

What is needed before a final diagnosis of these Copan carvings can be arrived at, is an intensive comparative study of the art of the Mayas, and a collation of all those designs which appear to be related to the "elephant" figures. In this way the true affinities of the latter might be established through linked series of variations. Until this can be done, the real genesis and evolution of the "elephant" designs in the New World will remain obscure and debatable. In the long run, possibly, Prof. Elliot Smith's hypothesis may prove to be justified, but that stage has by no means yet been reached, and, in spite of his confident and over-emphatic assertions, his case cannot be accepted as proven. In the meantime he has furnished a treatise which conveys a direct challenge, and has brought together and, in his own way, ably urged a mass of evidence in support of his diagnosis.

The book is worthy of serious consideration as a contribution to a debate upon a complex subject. Although in many ways attractive and stimulating, the volume shows evidence (in misprints, premature assumptions, and other blemishes) of having been produced hastily and under the influence of a dominating theory, which has militated somewhat against calmly critical and unbiassed treatment of the theme. The illustrations are numerous and for the most part clear, and the details which have been brought together and have been marshalled with debating skill will prove of much value in the further investigation of an interesting problem, which must still be regarded as in a "fluid" state.

Studies in Engineering History.

The Newcomen Society for the Study of the History of Engineering and Technology. Transactions, vol. 3, 1922–1923. Pp. xii+140+21 plates. (London: Science Museum, South Kensington, 1924.) 20*s*.

THE new volume of the Transactions of the Newcomen Society fully maintains the high standard reached in the two previous volumes. As studies in engineering history, the various contributions shed new light on matters of importance in industrial history, while the range of subjects treated will make a wide appeal. The principal contents of this volume consist of six papers read before the Society. The first of these is a sketch of the work of Simon Goodrich, who for many years held an important post as the mechanical engineer of H.M. Dockyard, Portsmouth. Making use of a mass of material deposited at the Science Museum nearly fifty years ago, Mr. Forward traces the connexion of Goodrich with Sir Samuel Bentham, the elder Brunel, Henry Maudslay, and other engineers of the time. Goodrich was assistant to Bentham in 1799 when the first steam engine at Portsmouth was installed for pumping at the docks. He also supervised the erection of Brunel's famous block-making machinery made by Maudslay and brought into use a short time before the battle of Trafalgar. The Navy at that time wanted more than 100,000 blocks a year. So far Mr. Forward has only given us the career of Goodrich up to 1805, but as he held office until 1831 the remaining documents should bring to light much of very great interest.

Mr. Rhys Jenkins has already contributed to the Transactions a paper on the iron industry, and we now have a sketch of the early history of steel-making in England. The period covered is roughly 1500 to 1750, that is, until about the time Huntsman introduced the manufacture of cast steel. Mr. Jenkins's researches have had very fruitful results, for he is able to show that the cementation process originated in England about the beginning of the seventeenth century. As the president of the Society remarked in the discussion, "it was flattering to think that, to the puddling and the Bessemer process they might now add the cementation process as being of English origin." As an appendix to his paper the author gives some transcripts from some books of accounts relating to the iron and steel works of Sir Henry Sidney in Sussex and Kent in the sixteenth century.

The three succeeding papers refer to widely different matters. Mr. Titley gives what might almost be called "The Natural History of the Windmill"; Mr. G. P. Baker is the author of a paper on Indian cotton prints and paintings of the seventeenth and eighteenth centuries, while Mr. Brownlie gives a striking review of the early history of the manufacture of coal gas. The industry, which had its birth in a small house in Redruth, has now grown into a key industry employing more than 150,000 men. Mr. Brownlie tells us that the first gas water-heater was made so long ago as 1825, and the gas stove was patented by Edwards in 1849. Modern developments of these most useful appliances date, however, from about 1890.

The last of the papers is by Mr. J. E. Hodgson on "Sir George Cayley as a Pioneer of Aeronautics." Though Cayley's name does not appear in the "Dictionary of Natural Biography," he must not be classed among the forgotten worthies. He was a country gentleman of the North Riding of Yorkshire, where he was born in 1773 and where he died in 1857. A man of the type of Edmund Cartwright, his claim to fame rests on his writings and experiments on mechanical flight and navigable balloons. Mr. Orville Wright indeed says that Cayley's articles in *Nicholson's Journal* of 1809–10 "show an understanding of the subject of aerodynamics hardly exceeded by any one except Lilienthal during the rest of the century." When Henson proposed in 1843 to construct an aeroplane of 150 feet span, it was Cayley who suggested that a better design would be to use three superimposed planes of far less span. Cayley's ideas regarding airships were also sound.

Besides these papers the volume under notice has a report of Sir Frank Baines's lecture to the Society on the preservation of historic buildings, and an account of Savery's work on the steam engine, by Mr. Jenkyns, being an amplified reprint of a paper contributed some years ago to the Devonshire Association; and also an hitherto unpublished letter from Faraday to Ampère preserved in the Staatsbibliothek at Berlin. The letter is dated 1821, the year Faraday made his memorable discovery of electro-magnetic rotation.

Huia Onslow's Life and Work.

Huia Onslow: a Memoir. By Muriel Onslow. Pp. viii + 247 + 5 plates. (London: E. Arnold and Co., 1924.) 12*s.* 6*d.* net.

IN the columns of NATURE Prof. R. C. Punnett wrote of Huia Onslow after his death in 1922 that his life "was the wonder of those who knew him," and of his achievement that, fine as it was, "finer still was the way in which it was won." This volume tells of the achievement and gives an indirect but none the less true and moving picture of the life.

The account of Onslow's scientific work is clear and simple. He obtained notable results in several branches of science. In genetics he studied the inheritance of coat-colour in rabbits and mice, with particular reference to the microscopic distribution of pigment granules and to the phenomena of albinism. He also carried out a long series of investigations into the inheritance of wing-colour in Lepidoptera, more especially the heredity of melanism in a number of species of moths. He gave much time to the study of the brilliant iridescent colours of some insects, discovering, by means of an exceptionally careful microscopic technique, the existence of thin films of chitin over certain butterfly scales, either lying flat on one another (like the skins of an onion) or set on edge (like the ridges of a ploughed field). The iridescence of these scales was shown to be due to the interference effects of the thin films of chitin and air, and the colour could be abolished by immersing the scales in liquid of the same refractive index as chitin, so that the air was expelled. In iridescent beetles no such structures could be found, and Onslow concluded for various reasons that a thin film of substance showing selective metallic reflection was responsible for the colours.

Turning to another branch of knowledge, Onslow was jointly responsible (with S. W. Cole) for the working out during the War of a standard nutrient medium for bacteriological purposes, now widely used, and of a method for the differentiation of typhoid and paratyphoid strains. He was also interested in protein chemistry, and was successful in solving the difficult problem of the quantitative estimation of the amino-acid tryptophane in casein.

Perhaps the most significant of Onslow's researches were those in what must eventually prove a fruitful field—the borderland between biochemistry and genetics, where he was a pioneer. Here undoubtedly his thorough and patient investigation would have yielded triumphs had he lived longer, and here especially it is to be hoped that his lead may be followed and his results extended.

One line of investigation concerned the chemistry of coat-colour in rabbits, more especially of dominant and recessive whiteness. It had been suggested that the melanin pigments present in hair were formed by the oxidation of the amino-acid tyrosine through the action of the enzyme tyrosinase. Onslow showed that extracts from the skins of coloured rabbits contain tyrosinase and form pigment when mixed with a solution of tyrosine, while extracts from the skins of albino rabbits (recessive white) do not form pigment from tyrosine. Albinism would thus appear to be due in this case to the absence of tyrosinase. In rabbits carrying a dominant factor for whiteness, on the other hand, extracts of the skin contain a substance which inhibits the production of pigment from tyrosine by extracts from coloured skins. The foundation of a genuine chemical explanation of one phenomenon of Mendelian heredity was thus established.

Again, Onslow found that the production of melanin in the black markings on the wings of the Cabbage White butterfly had a similar cause. There is no black pigment in the pupal stage; when there is access to the air, tyrosine is oxidised to melanin by the action of tyrosinase. The distribution of pigment was shown to be due to the localisation of the precursor, tyrosine, not of the enzyme.

A third example of this kind of work was the study begun by Onslow of the inheritance of a metabolic peculiarity of the Dalmatian hound, and the correlation of this with the inheritance of coat-colour, etc.

For a man of only thirty-one years this would have been a remarkable enough record of achievement even had he been in normal health and circumstances. Yet, at the age of twenty, he received an injury to the spine, while diving, which rendered him completely paralysed below the waist, and only left him partial use of his hands and arms. For the remaining eleven years of his life he never left his couch and was often in pain and sometimes in danger. As an undergraduate he had been interested widely rather than deeply in many activities, in science, literature and art, in mountaineering, hunting, and other sport, and the accident seemed not to check but rather to concentrate his energies. Resolutely and courageously he took up the serious studies which led to the work outlined above. He conquered untold difficulties by his immense determination, learning to perform many details of chemical manipulation himself, and becoming a master of microscopic technique and an expert draughtsman. He kept very wide interests outside his scientific work, and was the centre of a large circle of friends. In 1919 he married the fellow-worker in biochemistry and genetics to whom we owe the present volume. It will be valued by many who were his friends, and it may confidently be hoped that others also will be led by it to draw inspiration from a life at once tragic and triumphant.

Our Bookshelf.

Die Biogenen Amine und ihre Bedeutung für die Physiologie und Pathologie des pflanzlichen und tierischen Stoffwechsels. Von M. Guggenheim. (*Monographien aus dem Gesamtgebiet der Physiologie der Pflanzen und der Tiere*, Band 3.) Zweite umgearbeitete und vermehrte Auflage. Pp. viii+474. (Berlin: Julius Springer, 1924.) 4·80 dollars.

THE term "Biogene Amine" is employed by the author to denote a somewhat heterogeneous group of organic compounds occurring in the plant and animal world, the only common property of which is the possession of one or more amino, or substituted amino-groups. In the author's opinion, all the amines in question may be produced in one of two ways; either by synthesis from simple substances or by the break-down of more complex compounds; as an example of the former mode of origin he quotes the production of primary amines from ammonia and alcohols or aldehydes with subsequent conversion into secondary and tertiary bases, etc., while the production of amines by decomposition is exemplified by the hydrolysis of phosphatides, proteins, or the de-carboxylation of amino-acids such as is commonly brought about by micro-organisms. The first chapter contains a description of the general methods employed for the isolation of such amines, together with an account of their general properties. The rest of the work is divided up into ten sections, nine of which are devoted to compounds of known composition, while the tenth deals with substances of unknown constitution such as the active principles of the pituitary and thyroid glands. In the section dealing with phenylalkylamines, attention is directed by means of structural formulæ to the comparatively close relationship subsisting between phenylethylamine and a number of complex alkaloids indicating a possible mutual inter-relationship between these substances.

The volume contains a quantity of information concerning the sources, mode of preparation, physical and chemical properties, and, where possible, the biochemical and pharmacological significance of the substances discussed. Not the least valuable feature is the very complete list of references at the end of the book, which covers the literature of the subject up to the beginning of 1923. For the verification of these references and much other valuable assistance the author gratefully acknowledges his indebtedness to Prof. Barger, of the University of Edinburgh.

The Specific Heats of Gases. By Prof. J. R. Partington and W. G. Shilling. Pp. 252. (London: Ernest Benn, Ltd., 1924.) 30*s.* net.

PROF. PARTINGTON'S book is remarkable in that, instead of dealing generally with the properties of gases, it selects for fuller treatment the single property of specific heat. In the case of steam, tables of fundamental data are available, in which the numerical results have been subjected to a critical sifting during a period of many years and are at least approximately accurate. No similar trustworthy data for gases have been available hitherto, and the object of the present volume is to supply this gap. This has been done in part by means of new determinations by the authors, but also by a critical survey of existing data, many of which have been recalculated from the experimental figures in order to bring them all to a common basis. As a result of this survey the eleven pages of original data of Table A are reduced to a single Table B of molecular heats at atmospheric pressure, whilst the data of Table C, giving values for every 100° from 0° to 2000° and 2300°, occupy six pages.

Theoretical views are touched on only lightly, as they have been of no real service in predicting data, and can only with difficulty be reconciled with the figures already available. The book is not intended for beginners, and "the peculiar difficulties of the undeveloped mind" have not been considered in writing it; it is, in fact, intended as a reference book for specialists, and its construction is such that it will obviously be indispensable to all serious workers in this field for many years to come. The book is printed with unusually narrow margins, especially at the top of the page; this gives to the pages the novel appearance of a "high waist-line," and is not unattractive, whilst it obviously permits of a better utilisation of a given area of high quality paper.

Electricity and Magnetism for Advanced Students. By S. G. Starling. Fourth edition. Pp. vii+612. (London: Longmans, Green and Co., 1924.) 12*s.* 6*d.* net.

THE rapidity with which physical knowledge is extending at the present time must be a source of no small embarrassment to writers of the more advanced type of text-book. The progress in the subject of electricity during the twelve years which have elapsed since the publication of this book has been of such a fundamental character that it could not be relegated to additional chapters or appendices. A considerable amount of revision was thus necessary if the new matter was not to be too obviously grafted on the original. It is good to find that Mr. Starling has recognised this necessity, and congratulations are due to him on the result, for the book is now up-to-date, yet still homogeneous. He could not, of course, attempt to deal exhaustively with the electron theory and other modern developments, but he has given a very useful survey of them which will serve as an excellent introduction to more detailed study, the more so as it covers the widest possible field. For example, considerable space is devoted to the question of atomic structure, and an account of Bohr's theory of the hydrogen spectrum is given. In connexion with the latter it may be pointed out that the generalised quantum specification was given by Sommerfeld in 1916 (not 1911 as implied), but had been previously proposed by W. Wilson (1915).

Altogether about one-fifth of the book is concerned with the newer developments of the subject. There is no doubt that the time was ripe for this revision, and the present edition is sure of an appreciative reception from a wide circle of students.

The Continent of Europe. By Prof. Lionel W. Lyde. Second edition. Pp. xv+456. (London: Macmillan and Co., Ltd., 1924.) 10*s.* net.

THE revised edition of Prof. Lyde's well-known volume is in large part a reprint, with slight verbal changes, of the original work, but the chapters dealing with eastern Europe have been recast and rearranged. Here

and there statements have been left that now require emendation, *e.g.* the sovereignty of Bosnia (p. 146), and there are a few surprising omissions, *e.g.* the Murman railway. The treatment of Europe by political unities has many advantages except where the principle of self-determination has been allowed to run riot in the creation of small States. In such cases Prof. Lyde has not literally adhered to the system.

The book retains its merits and some of its defects. It is not a text-book to which the student can turn for full treatment of any part of Europe, and it contains many statements that need to be tested in the light of facts and close examination. In tracing causal relationships the author not infrequently jumps steps in his argument, and this does not make the book any too easy to read. On the other hand, he is never commonplace and never wearies his readers by telling him the obvious. Every page is stimulating, unexpected, and provocative. Prof. Lyde's picture of Europe is impressionist and extraordinarily vivid. To an uncritical mind the book might be misleading, but the intelligent reader with some knowledge at his command should find its ideas and suggestions invaluable in a study of the complex human problems of Europe.

The lack of coloured maps, which were in the original edition, is no loss. A folded black and white political map of central Europe has been added. The sketch maps and diagrams have been retained with little change. In a few cases revision would not be amiss.

Morphologie générale. Membres et ceintures des vertébrés tétrapodes : Critique morphologique du transformisme. Par Prof. L. Vialleton. Pp. viii + 710. (Paris : Gaston Doin, 1923.) 60 francs net.

PROF. VIALLETON is the leader in France of the school of modern transformists who believe in the Darwinian explanation of the evolution of genera and species by the process of the natural selection of small variations, but consider that the larger groups have arisen by a more rapid process of profound mutation. To illustrate this doctrine he presents us with a handsome and very useful monograph on the limbs and girdles of the cheiropterygial Vertebrata. The descriptions given of the various bones and articulations are clearly written, and the numerous illustrations throughout the text are excellent. As a work of reference for students of osteology this monograph is invaluable.

Students of morphology will naturally turn with special interest to the chapters dealing with the theoretical conceptions of the origin of the girdles and of the pentadactyle appendages, but they will be disappointed to find that there is no reference to Graham Kerr's important external gill hypothesis or to Goodrich's brilliant researches on the nerve supply of the limbs and his support of the lateral fold theory. The author seems to favour a theory expounded by A. C. Geddes in 1912, which is based on the supposition that there is an anterior and central region of the body of Vertebrata which is not and never was metamerically segmented. Such a theory is, no doubt, acceptable to the modern transformist, but it will be difficult to persuade the morphologists of the older school that the structure of the Vertebrata as we know them is not founded on a completely metamerically segmented ancestral type.

The New Theories of Matter and the Atom. By Prof. Alfred Berthoud. Translated from the French by Eden and Cedar Paul. Pp. 259. (London : George Allen and Unwin, Ltd. ; New York : The Macmillan Co., 1924.) 10*s.* 6*d.* net.

PROF. BERTHOUD'S book is very attractive both in its literary style and in the form in which it has been issued by the publishers. The scope of the book, dealing as it does with electrons, X-rays, radioactivity, isotopism, quanta and atomic structure, is familiar, so that the way in which the matter is presented is of more importance than the table of contents. Whilst it does not shirk the mathematical method of exposition, the book is eminently suitable for the reader whose knowledge of mathematics is too small to enable him to follow the more technical treatises of some of the physical writers.

As a professor of physical chemistry, the author is well acquainted with the limitations of the typical chemist in this direction, and the style and value of his book can therefore be expressed clearly by saying that it describes the physical developments of the present day in a form in which they can be understood and appreciated by chemists. This statement implies that the book is also suitable for the general scientific reader. The fact that most of the pages contain only a single fount of type, broken here and there by a series of cross-headings and varied only by a sparing use of italics, has the happy effect of creating the impression that the volume is not a mere text-book, to be used when "cramming" for an examination, but a book to be read and enjoyed in an arm-chair. It can therefore be heartily commended to those who read for pleasure, as well as to those whose reading is dictated by more urgent necessities.

Les Protéines. Par Jacques Lœb. Traduit de l'Anglais par H. Mouton. (Nouvelle Collection scientifique.) Pp. viii + 243. (Paris : Félix Alcan, 1924.) 10 francs.

THE original volume of which this is a translation is already familiar to English readers, and there is therefore no need to recapitulate the author's views with regard to the significance of the Donnan theory of membrane equilibria in explaining the colloidal behaviour of protein solutions. In his preface to the French edition, dated October 1922, the author stated that the work was to appear in two parts, the first part being devoted to the stoichiometric and colloidal properties of proteins and the second to the theory of colloidal properties.

The present volume, published in 1924, after the author's demise, represents the first half only of the complete work, the translation of the second half not yet being completed. It contains two new chapters dealing respectively with the electric charge and stability of suspensions and emulsions, and the crystalloidal character of the solutions of certain natural proteins in water. In the latter chapter the author discusses the question whether proteins are kept in solution by the same forces which determine the solubility of crystalloids in water or by the electric double layers which keep particles of oil in suspension in water, and arrives at the conclusion that the conditions

vary with different colloids. The translation is on the whole good, but, owing to an extraordinary oversight, the title of the second chapter is translated as being a quantitative proof, whereas in fact it appears in the original English edition as a qualitative proof.

Siam. By W. A. Graham. Third edition. (In 2 vols.) Vol. 1. Pp. xii + 396 + 45 plates. Vol. 2. Pp. viii + 320 + 69 plates. (London: Alexander Moring, Ltd., 1924.) 42*s.* net.

IT is surprising that Siam should be comparatively little known in Great Britain, notwithstanding the part played by Englishmen in its recent development under two monarchs of marked European sympathies, one of whom indeed had been educated in England. Mr. Graham's "Siam" should do much to dispel this ignorance, as well as to arouse interest in a country which should repay investigation. Written originally as a short handbook, it has now expanded into two volumes to cover the developments of the last twelve years. From the scientific point of view, Siam is almost virgin ground. For example, except for a few partial investigations, the botany has scarcely been studied, and apart from Skeat and Blagden's investigations of the wild tribes in the south, ethnological data are practically not available. Such conclusions as Mr. Graham has to offer are really based upon material drawn from the adjacent areas of Further India. Setting aside the drawbacks inevitable in view of the fragmentary state of our knowledge in certain departments, Mr. Graham's book is an informative account of the country and its resources, and of the manners, customs, beliefs, and social organisation of its people. In the chapter on music and the drama, the reference to the interesting and characteristic dances is disappointingly brief.

The Home of an Eastern Clan: a Study of the Palaungs of the Shan States. By Mrs. Leslie Milne. Pp. viii + 428 + 20 plates. (Oxford: At the Clarendon Press; London: Oxford University Press, 1924.) 16*s.* net.

MRS. MILNE'S account of the social life and customs of the Palaungs, a people living in a northern Shan State, but quite distinct from the Shans and belonging to the Mon Kmer group, is the outcome of her linguistic researches. When she first came into contact with them in 1906, their language had been little studied. In the course of several visits to their country, she compiled a dictionary, and in acquiring a vocabulary took her informants through every stage of the ceremony or custom for which she wished to ascertain the associated groups of words. By pursuing this method, she not unnaturally acquired a good deal of information bearing on the psychology, the social life and religion of the people. This information is the subject matter of the present book. The reading public, whether it apprehends the immense labour which has gone to the making of it or not, will at any rate appreciate the result. Mrs. Milne has produced a most readable and entertaining book which at the same time is of considerable scientific value. A welcome feature is that, as an outcome of her method, she deals very fully with the early stages of the life of the individual—a subject which frequently is very inadequately treated in the description of a primitive tribe.

Laboratory Experiments in Practical Physics: to Accompany the revised edition of Black and Davis' "Practical Physics." By N. Henry Black. Pp. ix + 245. (London: Macmillan and Co., Ltd., 1924.) 4*s.* 6*d.* net.

THIS is a revised and enlarged version of the author's Laboratory Manual published in 1913. In addition to some fifteen new experiments, introductory paragraphs have been prefixed to each experiment in which principles and practical applications are discussed. While these often provide interesting information (*e.g.* that every Ford automobile has sixteen permanent magnets bolted to its fly-wheel), one could wish that some attempt had been made instead to give a logical and connected development of the subject. No doubt the academic method has its limitations, but it is possible to progress too far in the opposite direction, and the practical or utilitarian method, if carried far enough, may retain little of real educational value. However, the latter method seems to be enjoying a considerable vogue in the United States at the present time, and, judged by the appropriate standards, the book is probably an excellent one. It is certainly clearly written and carefully compiled, but it is too distinctively American in outlook to be likely to appeal generally to students in Great Britain.

Examples in Chemistry. By Dr. William W. Myddleton. Pp. viii + 134. (London: Methuen and Co., Ltd., 1924.) 3*s.*

DR. MYDDLETON has produced a very useful and attractive set of examples for calculation suitable for use in schools and, with a little supplementing, for Intermediate Science students. There are no sections explaining the methods of calculation, and the book consists entirely of examples for exercise. This is in some ways an advantage, since the book can be used by teachers who prefer different methods of dealing with the subject. The questions will bring to the notice of students who work through them a number of points not often found in such books, and it is clear that the questions will fit in well with modern methods of teaching the subject. The book can be recommended as likely to prove very useful both to teachers and students. Answers to all the questions are given.

Applied Chemistry. By Prof. Ira D. Garard. Pp. vii + 496. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1924.) 15*s.* net.

A STUDENT who has graduated with first-class honours in chemistry from one of the universities may be expected to know very little about the chemistry of the common things of life. The composition of cheese, bread, leather, paints and varnishes, inks and boot polish will generally be unknown to him. The chemical changes taking place during the cooking and digestion of food will probably be less well known than those involved in "organic preparations." Prof. Garard's book, which does not treat of "Applied Chemistry" in the sense understood in Great Britain, will assist many chemical students to a better understanding of things which are mysteries to them, and is an interesting though rather superficial supplement to the standard treatises.

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.*]

Gravity Observations on the Indian Ocean and the Results of their Isostatic Reduction.

FOR years geodesists have anxiously awaited the securing of accurate gravity observations at sea for use in the determination of the shape of the earth and in testing the theory of isostasy. The gravity observations made at sea by Hecker, Briggs, and Duffield were a good step forward in this important work, but their results were not of the required degree of accuracy. They did, however, encourage us to believe that the problem would be solved in the not distant future.

Geodesists felt that the longed-for event had materialised when they read the communications from Dr. J. J. A. Muller, published in recent volumes of NATURE (September 15 and December 1, 1923; March 1 and May 3, 1924).

Dr. Muller reported on the determination of gravity at sea by Dr. F. A. Vening Meinesz, of the Geodetic Commission of Holland. Dr. Meinesz's work was done on a submarine, and the observations were made with the pendulum apparatus employed in the determination of gravity on land. I communicated with Dr. Muller, and also with Dr. Meinesz, and asked for further details in regard to the gravity work than had appeared in the letters in NATURE. I was given interesting and valuable information by them, but Dr. Meinesz will no doubt soon publish full accounts of his work, and it would be inappropriate to place in this note all the information that was furnished to me. I shall, however, discuss the isostatic reduction of five stations in the Indian Ocean for which Dr. Meinesz furnished the observed values.

Dr. Meinesz informed me that four pendulums were swung simultaneously in the same case or container in order to eliminate the effects of the motion of the submarine in which the pendulum apparatus was mounted. While observations were made, the vessel was submerged from 10 to 25 metres below the surface, in order to avoid the motion that would be imparted by waves if it were at the surface.

So far as I am aware, Dr. Meinesz is the first observer to use the pendulum apparatus on a boat, but it may be interesting to note that in a paper by me, entitled "The Bearing of Geodetic Investigations on the Geological Structure of the Pacific," presented at the first Pan-Pacific Scientific Congress conference held under the auspices of the Pan-Pacific Union at Honolulu, Hawaii, in August 1920, the following statement was made:

"It is hoped that a satisfactory apparatus may be devised for determining the intensity of gravity at sea, using special vessels or commercial vessels. There are several types of apparatus in existence, but no one of them gives results of sufficient accuracy for the study of isostasy. The writer suggests that it may be possible to obtain a fair value of the intensity of gravity at sea by the use of the land apparatus properly mounted on a vessel. The apparatus would have to be swung in double gimbals and should be placed near the point of minimum translation resulting from the pitching and rolling of the vessel." [1]

[1] Proc. First Pan-Pacific Scien. Conf., Honolulu, Hawaii, 1921, Spec. Pub. No. 7, Bishop Museum, p. 885.

It was with great satisfaction that I read that Dr. Meinesz had accomplished the accurate determination of gravity at sea with the use of pendulums. No doubt he arrived at the conclusion that the pendulum could be used independently of my suggestion in 1920.

Dr. Meinesz informed me that, so far as observations aboard the ship were concerned, the mean error from the observations alone were only one or two parts in 5 million in calm weather and rarely more than ten parts in rough weather. He feels that there should be better control of the temperature of the pendulum during the observations and of the rates of the chronometers.

The submarine was submerged at each station for 15 or 20 minutes, and the rates of the chronometers were dependent upon radio-signals received each day. It seems to me that in the work on a ship the principal difficulty arises from the fact that it is difficult to get a sufficiently accurate time interval from a chronometer which is only compared once a day with radio-signals. It would be better to have arrangements made with a radio-station to have accurate time-signals sent out each hour during the time gravity is being observed at sea. In this way, somewhat greater accuracy would be obtained.

The thought has occurred to me that a tuning-fork may possibly be used as the time-piece in getting accurate gravity observations with the pendulum, both on land and at sea. The tuning-fork would, of course, have to be made of material that would be only slightly affected in its elastic properties by changes in temperature, or some method would have to be devised which would enable one to determine with extreme accuracy the temperature of the fork. The material of the fork would necessarily have to possess constant elastic properties or values for any given temperature. If such a fork could be devised, a few oscillations of the pendulums compared with vibrations of the tuning-fork would give a value for the period of the pendulum. The tuning-fork, of course, would have to be standardised and rated at the base station.

With a letter dated August 2, 1924, Dr. Meinesz furnished the data given below for 13 stations in the Indian Ocean or in its ports:

OBSERVATIONS IN THE INDIAN OCEAN.

	Latitude North.	Longitude East of Greenwich.	g (unreduced).	$g_0'' - \gamma_0$.
1	11° 54′·5	53° 03′·5	978·286	+0·032
2	10 02	55 25	978·184	−0·006
3	7 57	61 53	978·136	+0·002
4	7 53	65 58	978·111	−0·021
5	7 56·5	68 46	978·102	−0·032
6	8 06	72 48	978·113	−0·024
7	7 20	77 28	978·099	−0·020
8	6 56·5 (Harbour of	79 51 Colombo)	978·118	+0·012
9	5 50·5	80 12	978·168	+0·080
10	5 32	80 12·5	978·014	−0·069
11	5 44	87 07	978·065	−0·020
12	6 02·5	92 50	978·024	−0·068
13	5 53·5 (Harbour of	95 19 Sabang)	978·181	+0·097

The values for g in the table above were reduced for the effect of the speed of the vessel during the observations, which lessened or increased the centrifugal force due to the earth's rotation. In computing the Bouguer anomalies shown in the last column, Dr. Meinesz applied a correction to take account of the depth of the submarine below the surface of the water.

It would have been interesting if isostatic reductions could have been made for all of these stations, but this was impossible in the short time that was available. However, reductions were made at the office of the U.S. Coast and Geodetic Survey by Mr.

C. H. Swick, Chief of the Section of Geodesy and Astronomy of the Division of Geodesy of the Survey, for stations 2, 3, 4, 5 and 11 of the above list. The results of Mr. Swick's work are shown in the following table:

PRINCIPAL FACTS FOR GRAVITY STATIONS IN THE INDIAN OCEAN ESTABLISHED BY DR. MEINESZ, OF HOLLAND.

No. of Station.	Latitude ϕ.	Longitude λ.	Depth, fath.[1]	γ_0.	Correction for Submergence.	Correction for Topog. and Comp.	Computed Gravity at Station (g_c).	Observed Gravity at Station (g).	Isostatic Anomaly.	
									$(g-g_c)$.	$(g-g_c-0{\cdot}008)$.
2	10° 02′	55° 25′	2300	978·187	+0·005	−0·016	978·176	987·184	+0·008	0·000
3	7 57	61 53	2400	978·129	+ ·005	− ·013	978·121	978·136	+ ·015	+ ·007
4	7 53	65 58	2400	978·127	+ ·005	− ·010	978·122	978·111	− ·011	− ·019
5	7 56	68 46	2400	978·128	+ ·005	− ·017	978·116	978·102	− ·014	− ·022
11	5 44	87 07	2200	978·081	+ ·005	− ·008	978·078	978·065	− ·013	− ·021
							Mean with regard to sign . . .		−0·003	−0·011
							Mean without regard to sign . .		·012	·014

[1] Depths were estimated from soundings shown on charts Nos. 854*a* and 854*b* of the Hydrographic Office of the United States Navy.

These five stations were selected because they were in the open ocean where the depths of the water vary from 2200 to 2400 fathoms, or from 13,200 to 14,400 feet. In metres, the depths are from 4025 to 4390.

The computed value at the station is based on the well-known Helmert formula of 1901, in which the first term is 978·030.

The values for g_c were corrected for the effect of the topography of the whole world and its compensation. The combined effect of these two are given in column No. 7.

In the column headed "$g-g_c$" are the isostatic anomalies based on the Helmert formula. It will be noticed that the largest anomaly is 0·015 dyne. The mean of the five anomalies with regard to sign is only −0·003, while the mean without regard to sign is only 0·012.

My formula, which is given in Special Publication No. 40 of the Coast and Geodetic Survey, is the same as the Helmert formula except that the first term is 978·038. The isostatic anomalies based on this formula are shown in the last column of the above table. With this formula the mean anomaly with regard to sign is −0·011, and the mean without regard to sign is 0·014.

It is possible that the uncertainty of the observed values at Dr. Meinesz's stations is of the order of magnitude of the difference in the two formulas used.

These small anomalies, with and without regard to sign, for the five stations over deep water in the Indian Ocean, seem to indicate very clearly that the crust of the earth below the area covered by the stations is in a state of isostatic equilibrium that is very nearly perfect. They also indicate that there is no large longitude term as advocated by Helmert and shown in his 1915 formula. That formula was discussed by me in Special Publication No. 99 of the Coast and Geodetic Survey.

It would appear from the results given above that Dr. Meinesz has made a valuable contribution to geodetic science, and that he has added another piece of evidence in favour of the theory of isostasy. Let us hope that he will be able to make isostatic adjustments for all of his stations in the Indian Ocean, the Mediterranean Sea, and in the Atlantic, and let us hope also that Dr. Meinesz will be able to continue his valuable work, and that geodetic organisations in other countries may embark on this new line of geodetic observations.

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Polarisation of Resonance Radiation in Magnetic Fields.

WOOD and ELLETT have shown that weak magnetic fields may greatly affect the polarisation of resonance radiation, the nature of the effect depending upon the relative orientation of the magnetic field and the electric vector of the exciting light. In the absence of a magnetic field, the resonance radiation emitted in the direction of the axis of Z by an atom excited by a beam of light parallel to the X axis and polarised with its electric intensity parallel to the Y axis is found to be more or less completely polarised, the per cent. polarisation, defined as $\frac{E_y - E_x}{E_y + E_x}$, varying from 90 in the case of mercury to 16·3 for sodium excited by both D_1 and D_2. The effect of a magnetic field parallel to the Z axis is to reduce this polarisation—the law of decay being quite accurately represented by an equation of the form

$$\frac{E_y - E_x}{E_y + E_x} = P_0 e^{-KH}.$$

The writer has recently observed that in D line resonance radiation with the magnetic field, the azimuth of the maximum polarisation is no longer parallel to OY, but is rotated in the direction of the Larmor precession. The angle of rotation is not directly proportional to the intensity of the field, probably because the interval between absorption and emission is not the same for all atoms. With D_2 resonance radiation of sodium, a field of 3·6 gauss rotates the azimuth of maximum polarisation 16·5°, and a field of 13·5 gauss rotates it 21°. Beyond this point, the azimuth of maximum polarisation cannot be determined with accuracy because of the decrease in polarisation due to the field. This rotation of the azimuth of maximum polarisation appears to be due to an actual rotation of the resonating atom. At first, it appeared that it might be due to rotation of the plane of polarisation by the layer of sodium vapour between the resonating atom and the observer, but such is not the case, for the magnitude of the rotation is independent of the thickness and density of this layer.

These observations were made in sodium freed from hydrogen as completely as possible and at temperatures of 85° to 95° C., where the vapour pressure of the sodium is so low that the time of a free path is large compared to τ, the average interval between absorption and re-emission.

It may be pointed out that by making suitable assumptions as to the manner of distribution of the time intervals between absorption and emission, we may calculate τ from the magnitude of this rotation.

E. Gaviola and P. Pringsheim have recently shown (*Zeit. f. Physik*, 25, 367, 1924) that the polarisation of sodium resonance radiation is due entirely to D_2, as one would expect from the character of the Zeeman levels involved. Using a different method, I made similar observations independently at about the same time (April and May of this year). The D lines were separated in the light from the exciting source by means of Prof. Wood's rotary dispersion scheme, and resonance radiation excited by either D_1 or D_2 alone.

D_2 alone shows polarisation. In addition, it may be pointed out that the $2p_1 - 2s$ and $2p_2 - 2s$ thallium lines show no polarisation in resonance radiation, as would be expected, since the *s* levels are above, while $2p_2 - 2d_2$ shows strong polarisation. The first and second doublets of the principal series of cæsium and potassium show polarisation in resonance radiation, due presumably to the more refrangible member of the doublet in each case.

For certain types of spectral lines, the theory of the anomalous Zeeman effect shows that resonance radiation excited in a magnetic field by plane polarised light must itself be partially polarised, because of the absence of certain components of the Zeeman pattern (Foote, Ruark and Mohler, J.O.S.A. and R.S.I., 7, p. 415, 1923.) I have found that in the *absence* of a magnetic field, lines of this type, *e.g.* $1s - 2p_1$ of sodium, $1s - 2p_2$ of mercury, $2p_2 - 3d_2$ of thallium, show polarisation; while those in which all components of the Zeeman pattern are to be expected, as $1s - 2p_2$ of sodium, $2p_1 - 2s$ and $2p_2 - 2s$ of thallium show no polarisation either with or without the field.

This work was done at the Johns Hopkins University, and is being continued at the Bureau of Standards.

A. ELLETT
(National Research Fellow).
Bureau of Standards,
Washington, D.C.,
November 15.

Heterogeneous Catalysis.

PROF. H. S. TAYLOR has pointed out to us that it is not clear from our paper on the heats of adsorption of oxygen on charcoal (Blench and Garner, J.C.S., 1924, 125, 1288) that the values were expressed in kgm.-cal. and also that we had not discussed the bearing of these results on the mechanism of heterogeneous catalysis. The latter point had, however, been reserved until further and more accurate data had been obtained, but, as it appears to be a matter of general interest, I propose to discuss it briefly in this letter.

The position, mode of orientation, and energy content of the atoms forming the surface of a homogeneous catalyst will very largely determine the part they play as individuals in the catalytic process, and it is not unlikely that a comparatively small number of the total atoms on the surface are the active agents in promoting the chemical change. This view is supported by the very large differences in energy content which have been shown to exist among the atoms on a carbon surface.

On admitting oxygen to an active carbon surface, heat is liberated which is due partly to the formation of carbon monoxide and dioxide and partly to the formation of an adsorption complex, C_xO_y. By allowing for the heats of formation of the two gases formed, it is possible to obtain a value for the "heat of formation" of the complex C_xO_y, which does not necessarily represent solely the heat liberated in its formation, but also includes any decrease in energy of the surface due to the liberation of the two gases. This heat of reaction, expressed in kgm.-cal./gm.mol.O_2 adsorbed, was often greater than the heat of formation of carbon dioxide. It decreased as the amount of gas admitted increased, and increased with the temperature of adsorption. The heat liberated ranged from 52 kgm.-cal. at 18° to 224 kgm.-cal. at 450° C. for the first small quantities of oxygen admitted. On subsequent admission of oxygen lower values than these were always obtained. These heats of reaction are of the same order as the energy liberated in the formation of the C-C linking as deduced from the heat of sublimation of carbon. Thus the valency of the surface carbon atoms is very far from being saturated by neighbouring carbon atoms.

The ratio of the oxygen atoms adsorbed to those giving rise to carbon monoxide and dioxide decreases with increase in temperature; in other words, a proportion of the atoms adsorbed at the low temperatures is liberated as gases at the high temperatures. Thus the differences between the heats of adsorption at two temperatures must be due to different selections made from the carbon atoms on the surface, and hence are an indication of the very widely differing energy contents of these atoms. The oxygen atoms which remain on the surface at any one temperature will be to a large extent those held by a number of carbon atoms, while those adsorbed on exposed carbon atoms, which are less tightly bound to the surface, will give rise to the oxides of carbon. Thus the high heats of adsorption are not due solely to the energy liberated on combination of the oxygen atoms with the surface, but also to that liberated on the removal of the exposed carbon atoms, *i.e.* carbon atoms with a high energy content, from the surface. Both energies are undoubtedly very high compared with the heat of formation of carbon monoxide, but without further work it is difficult to decide between their relative importance. The most active atoms are, however, removed on the first admission of oxygen.

A point of difference between the reactions of carbon and oxygen and a catalytic reaction lies in the fact that the atoms of the catalyst do not leave the surface although their relative positions with respect to one another may change during the reaction. It is, however, clear that those atoms lying in an exposed position on the surface, by virtue of their high energy content, will play a large part in the chemical process. They will be the most likely to possess the energy necessary for promoting the trigger action of catalysis. Also it can be seen why the surface becomes increasingly effective with use. If part of the heat liberated during the heterogeneous reaction is absorbed by the surface, this may result not only in an increase in the total surface but also in an increase in the proportion of exposed atoms on the surface, *i.e.* an increased free energy of surface per sq. cm.

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Seed Inoculation of Lucerne (*Medicago sativa*) and its Relation to the Motility of the Nodule Organism in Soil.

THE successful results that are being obtained in other countries from the inoculation of lucerne seed with the nodule organism (*Bacillus radicicola*, Beyerinck) have stimulated investigation of this subject in England. In this practice the details of the method used in the inoculation are of great importance. The method consists essentially in making a suspension of the bacterial culture in some liquid, and in using this suspension to wet the seed. In this way each seed is coated with a film of liquid in which the bacteria lie. There is evidence that after penetrating the tissues of the root the bacteria are unable to pass for any significant distance along it. Consequently, when the seed has germinated, the bacteria must progress or be carried through the soil in order to reach from the seed-coat to the various parts of the root system, where nodules are to be formed. A study of the factors affecting the motility

of the organism and its passage through soil has, therefore, an important bearing on the technique of seed inoculation.

A modification of Winogradsky's technique for staining bacteria in soil (1924, *Comptes rend. Acad. Sci.*, vol. clxxix. p. 367) has enabled the present authors to follow the passage of the nodule organism through sterile soil. It has been found that they will progress through light soil at an approximate rate of one inch in 24 hours, though the rate is affected by the soil texture. When a drop of water containing the bacteria in the rod stage is added to sterile soil, the spread of the organisms from the point of inoculation does not begin until after a considerable interval, and its commencement is accompanied by the conversion of a large percentage of the bacteria into cocci. If the inoculum consists of a suspension in milk, the bacteria begin to spread through the soil after a shorter interval. This is perhaps an explanation of the successful results obtained by using a suspension of the bacteria in skim milk for wetting the seed, a technique now practised in Scandinavia for inoculating lucerne. The effect of milk also emphasises how important is the nature of the liquid used in making the bacterial suspension for seed inoculation.

Bewley and Hutchinson (*Journ. Agric. Sci.*, 1921, vol. x. p. 144) found that the production of the motile coccoid stage of *Bacillus radicicola* was greatly stimulated by the presence of phosphates. The effect of inoculating sterile soil with a suspension of the bacteria in skim milk containing 0·1 per cent. soluble calcium phosphate, $CaH_4(PO_4)+2H_2O$, was therefore tested. It was then found that the spread of the organisms from the point of inoculation commenced almost immediately. It seemed probable that the use of a bacterial suspension in the above solution for wetting the seed would increase the chances of nodule formation by hastening the spread of organisms from the seed-coat, and thus increasing the volume of soil explored by them in a given time. Pot culture tests of seed inoculation were therefore made with lucerne, in which a bacterial suspension in a 0·1 per cent. solution of $CaH_4(PO_4)_2+2H_2O$ in skim milk was compared with a suspension in skim milk alone, such as is now in practical use. On averages of 10 parallel pots, increases in nodule numbers of 93 per cent. and 73 per cent. were obtained in two experiments by the addition of phosphate to the milk. There was also a favourable effect on the yield of the crop. The work is being continued and will be published in detail at a later date.

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Capillary Action: Transpiration.

IF a capillary tube, A, Fig. 1, with a wedge-shaped cut in it at a distance of about 10 mm. from its upper end, at right angles to, and deep enough to make a breach in one side of its aperture, is lowered slowly into water the rising column of water pauses for an instant when it reaches the gap, which is necessarily higher than the surface of the water into which the tube is being dipped, and then leaps past it and rises to the top of the aperture.

When this tube is fixed in a cork as shown in Fig. 1; the cork inserted as a stopper into the mouth of a cylindrical vessel, B, containing water; the vessel, B, fixed in a circular piece of cork which acts as a stand for it; and a small sheet of thin blotting paper, *b*, drawn far enough into the cut to touch the thread of water in the aperture, the capillary tube acts the part of the stem of a plant, the blotting paper that of a leaf, and transpiration commences and continues uninterruptedly through the latter so long as the water lasts. A current of water flows up the aperture of the capillary tube and through the gap in it to the blotting paper from which it is evaporated continuously without creating any visible disturbance in the thread of water contained in that part of the aperture above the gap. As the surface of the water inside the vessel, B, is being lowered, air flows into the space above it through a fine capillary tube, *a*, which passes through the cork near the larger tube.

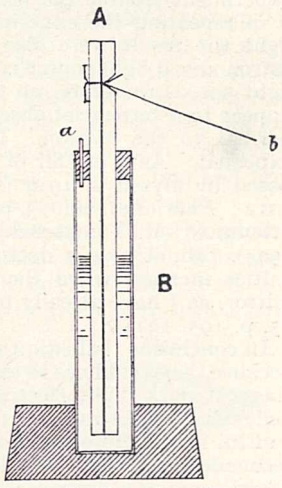

FIG. 1.—Capillary tube to illustrate transpiration. Half real size.

In an experiment with this apparatus carried out in May 1922, the dimensions of the sheet of blotting paper were 33 mm. by 43 mm. The edge of the sheet was drawn into the cut by means of a thread which passed round the back of the capillary tube and slightly compressed a small india-rubber tube which acted as a spring to keep it taut as shown. On placing the apparatus on one scale of a chemical balance in a glass case, in which there was also a basin containing chloride of calcium, and balancing it with weights in the other scale, it was found that when both scales were left free to move, one rose and the other fell so rapidly and continuously that their movement was clearly visible to the unaided eye.

Observed during a period of 491 minutes, it was found that the total weight of water evaporated in that time amounted to 1·1958 gm., or at the rate of 2·43 mgm. per minute. The aperture of the capillary tube was elliptical. Its area in cross-section, ascertained by calibration with a thread of mercury 93·2 mm. in length at 20° C. and weighing 3·21 mgm., was 0·02542 mm². It was thus equal to that of a circle 0·18 mm. in diameter, and the velocity of flow of water in the aperture was at the rate of 95·5 mm. per minute.

W. GALLOWAY.
17 Park Place, Cardiff.

The Ballistic Theory of Light and the Michelson-Morley Experiment.

IN a note regarding my theory of variable stars, published in NATURE of October 11, p. 550, it is suggested that some difficulties would probably arise on the ground of the Michelson-Morley experiment. As the point is a very important one, I should be glad if space can be given me to make it clear.

The ballistic principle, on which my theory is entirely based, requires that light emitted from a source movable relatively to the observer shall exhibit a velocity compounded of the common velocity *c* and of that of the source. As in the Michelson-Morley experiment the source is at rest in respect to the observer, the ballistic principle requires that light travels with the same velocity *c* in all directions. Hence no displacement of the interference fringes may appear in revolving the whole apparatus. The negative result of Michelson-Morley experiment evidently agrees with the ballistic theory. The same

agreement must hold, in all the experiments directed to detect the total motion, for the ballistic principle has been just introduced from Ritz for the purpose of extending the mechanical principle of relativity to all physical phenomena. This means that the ballistic theory is a *relativistic* one, like that of Einstein, with the two advantages of preserving classical mechanics and of explaining variable stars.

For the sake of completeness, it must be remembered that only in one event would the Michelson-Morley experiment trouble the ballistic theory, that is, only if in repeating the experiment with extra-terrestrial light the result were also negative. Of course, an astronomical light source is not dragged by the earth; light speed, therefore, on the ballistic theory should appear to a terrestrial observer different towards and normal to the motion. Thus, an effect should be expected. As a matter of fact, this experiment proposed by myself in 1912 (*Nuovo Cim.* vol. 3, p. 345, 1912; *Phys. Zeit.* vol. 13, p. 1129, 1912), and recently attempted (R. Tomaschek, *Ann. d. Phys.* 73, p. 105, 1924), cannot give a decisive result, for many difficulties increase when the light falls on a movable mirror, as I have already pointed out (*Ann. d. Phys.*, 75, p. 195, 1924).

In conclusion, ballistic theories are very promising, because they enable us to explain all the phenomena of classical optics and electromagnetism, including the deflexion of light rays near the sun, and they are also fruitful in explaining variable stars, while they finally reconcile both the undulatory and the quantum theories required by recent discoveries.

M. LA ROSA.

R. Università-Istituto Fisico, Palermo,
November 18.

The Rare Gases of the Atmosphere.

ONE of the unsolved questions of geophysics is whether the earth's atmosphere is mainly primitive, or whether its constituents have for the most part been evolved from the interior of the earth since solidification. Dr. Aston's letter (NATURE, Nov. 29, p. 786) may help to answer this question. The tendency of a gravitating planet to collect heavier molecules to itself, and in certain circumstances to lose the lighter ones, would not by itself account for the rarity of the inert gases. Xenon and krypton have the highest molecular weights of all the atmospheric gases, and would therefore be the most abundant if this were the sole explanation. Possibly the ability of other elements to form stable solid and liquid compounds has co-operated. If so, we may contemplate a heated primitive earth surrounded by a tenuous atmosphere consisting largely of the rare gases as at present represented, with the possible exception of helium. The greater part of the atmosphere, the water, and perhaps the helium, would have been emitted from the interior in the course of the earth's development.

I am much indebted to the reviewer for his careful and kind notice, in NATURE of November 22, of my book "The Earth." He has, however, misunderstood me in regarding as a lower limit my estimate of 0·14 astronomical unit as the radius of the primitive sun, at the time of the tidal encounter. It is an upper limit, based on the fact that the sun would have been too cold to be gaseous if its size were any greater. I doubt whether any serious change will be necessitated by the sudden death of the giant and dwarf theory while my book was in the press, but cannot as yet be sure.

HAROLD JEFFREYS.

The Temperature of Mars.

IN a recent paper (Pub. Ast. Soc. of the Pacific), Nicholson and Pettit calculate the temperature of the planet Mars, based on their radiation measures made at Mount Wilson. Most confidence is placed on measures made in the region 8 to 14μ, by the use of filter screens, and an emissivity of unity is assumed for all wave-lengths. However, Mars, being probably composed of material not unlike the earth, would radiate more like sand or quartz than like a black body, and it can be calculated from curves given by Wood ("Physical Optics") and data given by Rosenthal (*Wied. Ann.* 68, p. 783), that the average ratio of the emissivity of quartz to that of a black body in the region 8 to 14μ, is 0·819. The values of the emissivity of quartz given are far below that of a black body between 8 and 10μ; they are nearly the same from 10 to 14μ; the average ratio is taken.

It is believed that temperature calculations using this value for the emissivity, and the fourth power radiation law, will be more correct than when an emissivity of unity is assumed. For a given amount of received radiation, the temperature of the radiating body will be higher for a lower emissivity. Accordingly, the temperatures T given by Nicholson and Pettit have been recalculated by applying the method separately to each value of T.

$$\frac{T^4}{T_c^4} = 0{\cdot}819.$$

	T.	T_c.
Centre, full phase . .	280° absolute	294°
Limb	260°	273°
Pole cap	205°	216°
Integrated disc . .	250°	263°

CARL T. CHASE.

Norman Bridge Laboratory of Physics,
Pasadena, Cal., November 15.

Low-Voltage Arc Spectra of Copper.

IN my letter which appeared in NATURE of October 4, p. 501, I reported work I had carried out on the low-voltage arc in copper vapour. I have since then succeeded in obtaining the line absorption of normal copper vapour. The lines which are certainly absorbed, and which, therefore, should be 1*s* combinations, are:

3247·55	2244·24
3273·97	2225·67
2492·14	2165·06
2441·63	

With slight uncertainty there are also the lines:

2181·68
2024·33

In addition, I find from combinations that 2178·91 should also be absorbed, but this is not sufficiently resolved from 2179·39 by the small spectrograph used.

By subtraction from the term 1*s*, the above lines give energy-levels which are all confirmed by combinations with other known terms of the copper arc spectrum. From the arc lines previously reported I have also calculated a number of other terms.

A paper is being written incorporating all these results.

A. G. SHENSTONE.

University of Toronto,
Toronto, Canada, November 26.

The Origin of Land Vertebrates.[1]

By Prof. E. S. GOODRICH, F.R.S.

WE are all agreed that the four-footed terrestrial vertebrates or Tetrapoda have arisen from some fish-like aquatic ancestor. Two chief changes must have occurred in the passage from water to land—one connected with respiration, the other with locomotion. Moreover, the land animal must have acquired a resistent skin. The fish breathes oxygen dissolved in water, which it takes in by its mouth and expels through its gill-slits, the gills on its gill-arches being organs of respiration.

In the tetrapod, the respiratory organ is a ventral bilobed diverticulum of the pharynx; air is taken in at the external nostrils, passes by the internal nostrils into the buccal cavity, and is thence forced or sucked through the median ventral glottis into the trachea and so to the distensible lungs.

The fish, also, swims by undulations of its body and tail and with the help of paired fins, stiff outstanding folds of the body-wall, each with an internal skeleton movably articulated at its base to the supporting limb-girdle. The walking limbs of the tetrapod, on the other hand, consist of paired pectoral and pelvic projecting limbs built on essentially the same plan, and each subdivided by movable articulations into three regions, the outermost bearing typically five digits. Hence it is called the pentadactyle limb.

The problem before us is, then, to explain how the walking tetrapod evolved from the swimming fish without any sudden alteration of the structure and function of its parts, by a series of gradual steps each of advantage in the struggle for existence.

Before considering the possible claims of any known fish to be considered as ancestral to the land vertebrates, we must first attempt to determine, without going into detail, what must have been the fundamental structure of the common ancestor of all the Tetrapoda. Since the Amphibia still lay their eggs in water and pass through a larval stage provided with gills, it is agreed that they represent the most primitive group of tetrapods living at the present day. The problem is thus narrowed to that of the origin of the class Amphibia. But all the modern forms of the class are highly specialised remnants of a much more ancient and primitive group known as the Stegocephalia (or Labyrinthodontia), which flourished in Carboniferous and Permian times—many of them far larger and more formidable animals than their degenerate modern descendants.

Briefly, we may conclude from a study of extinct and living Amphibia that the primitive ancestral tetrapod had the following chief characters in addition to the lungs and pentadactyle limb already mentioned. It was a heavily built animal, shaped somewhat like a salamander or newt, with a large head, a complete covering of bony plates and scales underlying a soft skin protected by a renewable outer cornified layer and provided with abundant glands to keep it moist when out of the water. The roofing of the skull was pierced by two orbits, two external nostrils, and a median pineal foramen. Internal nostrils opened on the palate. The Eustachian tubes led to a tympanic cavity closed by a tympanic membrane behind the quadrate. A columella auris extended between this membrane and the auditory capsule. Probably the lateral line system of sense organs, present in all fish and in the aquatic larvæ of Amphibia, persisted even in the adult. The brain had well-defined paired cerebral hemispheres. The heart was asymmetrically twisted and the atrium subdivided into left arterial and right venous auricles. The lung received venous blood from the sixth aortic arch and returned it aerated to the heart by pulmonary veins. A vena cava inferior made a short cut from the kidneys to the sinus venosus. The rectum and urino-genital ducts opened into a common cloaca.

Now we may ask from what known kind of fish could such a primitive tetrapod have evolved? What group of the Pisces is sufficiently advanced and at the same time sufficiently primitive to give rise to such a form?

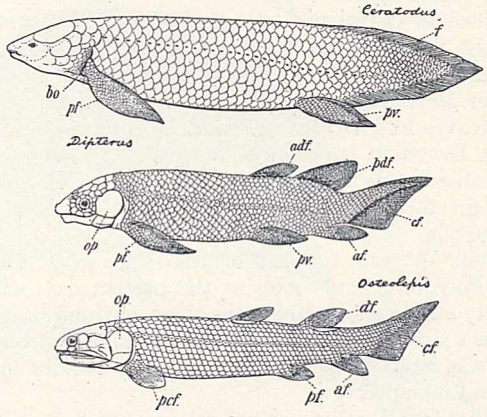

FIG. 1.—*Ceratodus forsteri*, the lung-fish of Australia; *Dipterus valenciennesii*, a Devonian dipnoan (after Traquair); *Osteolepis macrolepidotus*, a Devonian teleostome (after Traquair). From "A Treatise on Zoology," Part IX., by kind permission of Messrs. A. and C. Black.

We divide the Pisces into Chondrichthyes (sharks and rays), with a purely cartilaginous skeleton, and Osteichthyes, in which bone is present. Clearly the Chondrichthyes, with neither true bone nor true scales and with no form of air-bladder or lung, are not eligible. The second group, the Osteichthyes, contains the Dipnoi and the Teleostomi. We shall see that of these the Dipnoi alone display a considerable assemblage of characters which the ancestor of the Tetrapoda must have possessed.

The teleostomes include Polypterus and the Actinopterygii (Acipenser, Amia, Lepidosteus, and the Teleostei and many fossil forms). Of these the Teleostei, which appear only in the Jurassic strata, may be dismissed at once as far too specialised and modern—for it is obvious that the common ancestor of the tetrapods must have diverged from the piscine stem in Carboniferous if not in Devonian times. But even the lower living Actinopterygii show specialisations in the skeleton, brain, and viscera which prove that they all belong to side branches not in the direct line of ancestry.

In the Devonian strata, however, are found certain very primitive teleostomes, such as Osteolepis, which much more closely resemble what we believe to have been the ancestral form.

[1] Substance of a paper opening a discussion in Section D (Zoology) of the British Association at Toronto on August 13.

Indeed, as we pass downwards, we find a gradual convergence in structure between Teleostomi and Dipnoi, and between these and the Stegocephalia, which seems unmistakably to point to a common undifferentiated form from which all three could have evolved. It is just this sort of convergence as we pass to earlier and earlier fossils which makes the study of palæontology so fascinating—affording evidence not only that evolution has taken place, but also enabling us to trace out the course it has actually followed.

Following, then, the teleostomes down into the Devonian, we find that the osteolepids acquire a complete covering of thick scales of the peculiar structure I have named cosmoid, a complete set of roofing bones to the skull which may be compared almost bone for bone with those of the Stegocephalia (a comparison further borne out by the very similar disposition of the lateral line canals and the pineal foramen). Not only were there ventral external nostrils but also internal nostrils on the palate, as Prof. Watson has shown. Both the pectoral and the pelvic fins had outstanding scale-covered lobes.

Allied to Osteolepis, but, it would seem, somewhat off the main line of descent, are the Rhizodontidæ, represented, for example, by Eusthenopteron from the Upper Devonian of Canada and so well described by Whiteaves and Bryant. Primitive as they are, even these Devonian teleostomes are probably already too specialised in their jaw apparatus, large opercular bones, and fin skeleton to be the actual ancestors of the Tetrapoda.

There remains to be considered the very isolated fish Polypterus, surviving at the present day, with a closely allied genus, only in the rivers of tropical Africa. It has a strong superficial resemblance to the osteolepids and was long ago placed with them by Huxley in the group Crossopterygii.

Pollard and others since, relying chiefly on similarities in the roofing bones of the skull, have claimed that Polypterus is, of all living fish, that most closely allied to the tetrapods. The resemblance is, I think, to a great extent deceptive, and only such as might be expected in any fairly primitive fish. It is true that it has a ventral lung-like air bladder supplied from the sixth aortic arch. Nevertheless the structure of its scales, the jaw apparatus, the position of its double nostrils on the outer surface of the snout, the absence of a cloaca, the skeleton of the pelvic fin and girdle, and its specialised brain show that Polypterus is well on the actinopterygian line of specialisation, as I endeavoured to show in a paper on the subject before the British Association in 1907. Indeed there is some reason to believe that it may be the living representative of the ancient group of Palanoniscidæ.

Finally we come to the Dipnoi, that ancient branch of the Osteichthyes dating from Devonian times, but still surviving to-day in isolated remnants, of which the Australian lung-fish Ceratodus is the most primitive genus. Although the modern forms have a highly specialised dentition and have lost many of the dermal roofing-bones of the skull and marginal bones of the jaws, yet they retain several important characters indicating affinity with the Tetrapoda. They have internal as well as external nostrils, and a lung sac opening ventrally, receiving venous blood from the sixth aortic arch and returning aerated blood directly to the heart. The heart itself is remarkably amphibian in the structure of the truncus arteriosus, in the tendency of the valves of the conus to fuse to a spiral longitudinal septum; and even the atrium is beginning to become subdivided, so that the venous and arterial blood-streams pass separately to the right and left sides of the ventricle. The vena cava inferior and the anterior abdominal vein are well established. A cloaca is present, and the urino-genital organs conform to the amphibian plan, as do also the eggs and the larval forms. But more important still is the structure of the brain, which possesses distinct paired cerebral hemispheres. Even the skin resembles that of the Amphibia, being provided with abundant multicellular glands. All these resemblances, both conservative and progressive, can scarcely be due to convergence.

Two important points remain to be mentioned. In all the primitive tetrapods, the hinder region of the palato-quadrate bar (the upper division of the mandibular arch) is not only firmly attached to the skull by basal and otic processes, but also bears an ascending process separating the profundus from the maxillary branch of the trigeminal nerve. Among all the fishes, the Dipnoi alone are known to show this typical disposition.

The second point is that they alone among known fishes, with the possible exception of the more primitive osteolepids, have pectoral and pelvic fins of the same structure—thus sufficiently alike to have given rise to paired walking limbs. In other fishes the pelvic fins are too much reduced or specialised, too unlike the pectorals, to have developed into the tetrapod hind limb. The early Devonian dipnoan Dipterus approaches so closely to the osteolepids (in the structure of the skull, scales, fins, etc.), that we may be sure these forms cannot have moved very far from the common starting-point.

We may conclude that the earliest Osteichthyes diverged into teleostome and dipnoan branches and that the tetrapods arose from the base of the latter branch before the Dipnoi had acquired their characteristic specialisation in palate and dentition. The Devonian Osteolepidæ and Dipnoi seem to have been fresh-water forms, and it is probable that the transition from aquatic to terrestrial life took place in streams and pools, whence access to land was easy.

What exactly were the transitional steps from fin to walking limb we do not yet know. The fin skeleton of the osteolepids is scarcely known, and that of the rhizodonts is probably already too specialised. The living Dipnoi, on the other hand, help us to understand how aerial was substituted for aquatic respiration. For, while retaining gills and open gill-slits, they have become adapted to survival in rivers liable to be dried up or become foul in dry weather by acquiring a nasal passage from external to internal nostril (by closure of the nasal groove) and a lung for breathing air taken in at the surface. The lung had no sudden origin; but, as suggested by A. Goette and Spengel, was probably derived from a posterior pair of gill pouches which failed to open to the exterior, retained an ample blood-supply, and joined together ventrally. To this day the lung first appears in tetrapods as a pair of diverticula of the pharynx.

Thus without break or sudden violent change of habit or structure could an aquatic ancestor have evolved into an animal living on dry land.

The Optical Planetarium at Munich.

MECHANICAL devices intended to represent the motions of the planets date back to a very remote period and are said to have been constructed by the Chinese some 2000 years before the Christian era. It is certain that Archimedes and Posidonius constructed some such apparatus. Machines representing the Ptolemaic system were designed at different epochs up to the time of Copernicus.

In the latter part of the seventeenth century, machines were made by Roemer and Huyghens in conformity with the Copernican plan of the solar system, and various instruments have been devised at intervals up to the present day. It is interesting to note that Roemer presented one of his construction to Flamsteed, the first Astronomer-Royal. These machines all represent the motions of the planets by purely mechanical means, the planets being represented by balls and made to move in their orbits by systems of gearing. As a rule, a system of vertical concentric tubes of different lengths is employed, the innermost being the longest. To the upper end of each tube a radius vector is attached which revolves once for each revolution of the tube, and the lower ends of the tubes form the arbors of toothed wheels which are geared up to a vertical axial. Through this, axial motion is imparted to the whole machine. The radius vector attached to the top of each tube connects the tube with the ball representing the planet, and consists of two parts of different length. The longer is made to revolve round the tube, as has just been described, and the shorter, which carries the planetary ball at its extremity, is made to revolve round the extremity of the longer arm with the same angular velocity as the latter, but in the opposite direction. In this way true elliptic motion is produced, the ratio of the lengths of the two arms determining the eccentricity. The motion of the short arm is often produced by means of a pulley fixed to the planetary tube and connected by an endless cord with another pulley which is situated at the extremity of the longer arm and to which the shorter arm is attached.

It will be noticed that a person following the motions of these mechanical devices is in the position of an observer outside the solar system. Recently a new type of planetarium has been erected at Munich, and it seems to possess some striking advantages over the older and more cumbersome models. In the first place, the mechanical apparatus is compact, and the *images* of the planets are projected *optically* on the surface of a large hemispherical dome at the centre of which is situated the projecting mechanism. Images of fixed stars are also projected on the dome, and an onlooker at the centre of the dome sees the motions represented on a short time-scale as they actually appear to a terrestrial observer. A general idea of the planetarium will be obtained from Fig. 1. The dome is 33 feet in diameter.

Images of the 4500 fixed stars of the first to the sixth magnitude are projected on the dome by a straightforward method. Thirty-one projection bodies are mounted upon a spherical shell of gun-metal with a lamp of 200 candle-power at its centre, and are so divided up that thirty-one lantern slides derived from star-maps form a continuous picture. This device will readily be comprehended by a glance at the top portion of Fig. 2, which is a photographic reproduction of the entire projection apparatus. The stars are represented by means of discs of varying diameters, and the Milky Way is projected by means of a number of small lantern attachments giving nebulous images. The whole of this part of the apparatus is mounted upon an axis corresponding to the earth's polar axis, so that the projected images may move in such a way as to imitate the diurnal motion.

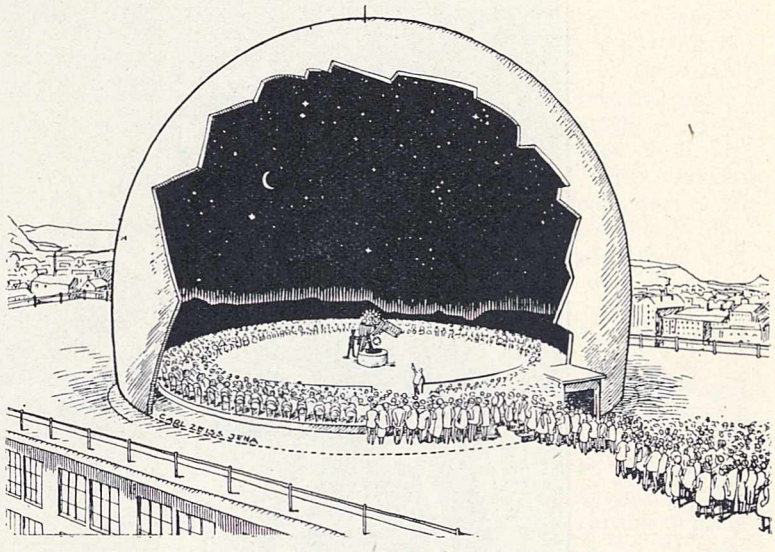

FIG. 1.—Sketch illustrating the planetarium in use.

The projection of planetary motions on the dome is necessarily a rather more complicated affair. The motions of five planets are represented, namely, Mercury, Venus, Mars, Jupiter, and Saturn. Uranus and Neptune are not represented, as they are purely telescopic objects. The motion of each planet is projected by a separate projector, and the principle of the projectors is briefly as follows. By means of a straightforward mechanical device two small steel balls representing the planet and earth are made to revolve round a central point representing the sun, and these balls are connected by a trellis linkage capable of adapting itself to changing distances. A small projection apparatus is attached to the end of this linkage, and consequently the motion of the projected planetary image on the dome represents the motion of the planet *as seen from the earth*. The planes of the paths of the planetary balls in these projectors are inclined at the correct angles to the planes in which the balls representing the earth move, these latter planes being all parallel to each other and inclined at the correct angle to the polar axis of the fixed star projector. The inclinations of the orbits of the planets and the obliquity of the ecliptic are thus taken into account. The orbits of the balls

representing the planets in the projectors are circular, but a crank mechanism takes into account the velocity changes associated with the eccentricity of the orbit. Briefly, the crank mechanism compels the planetary ball to describe a circular path about an eccentric point representing the sun. There is still a residual error left in the vectorial angle which in the most unfavourable case (Mercury when nearest to the earth) leads to an error of 6° in the position of the projected image. In the case of Mars, which comes next to Mercury in eccentricity, the residual errors amount to only $\frac{1}{5}$ those obtaining in the case of Mercury.

In the case of the sun projector, the trellis work to which the projection apparatus is attached simply joins the ball representing the earth to a fixed central pin representing the sun. The moon necessarily presents various complications arising from the comparatively rapid changes in the lunar orbit. The earth is represented by a fixed central pin, and the moon by a ball rotating about another central pin as in the case of the planets. This last central pin is set at an angle to the plane of the ecliptic, thus taking into account the inclination of the moon's orbit, and furthermore is made to rotate about a line perpendicular to the ecliptic, so as to represent the progression of the nodes. No attempt is made to represent the eccentricity of the lunar orbit, as it would have been of no avail unless some mechanism was introduced in order to represent the motion of the apses. This would have led to great difficulties in the gearing mechanism, and the lunar orbit is accordingly represented as circular. This leads to a maximum positional error of about 6°. The phases of the moon are imitated by mounting a small revolving stop behind the circular diaphragm which furnishes the projected image. Actually such a stop would represent the phases correctly through one complete lunation, but would furnish their mirror images during the next. Accordingly the phase projecting attachment has two alternately operating projection heads. The phases of the planets are not reproduced, since they are not naked-eye phenomena.

The projectors for the sun, moon, and planets will be seen on the left-hand side of Fig. 2. The precession of the equinoxes is also allowed for in the mechanism. The whole apparatus is driven by an electric motor, and by means of a change gear a sidereal day can be condensed into $4\frac{1}{2}$ minutes, 2 minutes, or 50 seconds. In order to exhibit the motions of the sun, moon, and planets more rapidly, a device is attached by means of which the polar axis can be disengaged and the motions of the solar system run at a rapid rate (exhibiting the annual changes in $4\frac{1}{2}$ minutes, 50 seconds, or 7 seconds) against the fixed star sky, the latter being unaffected by diurnal motion and showing only the slow precessional change.

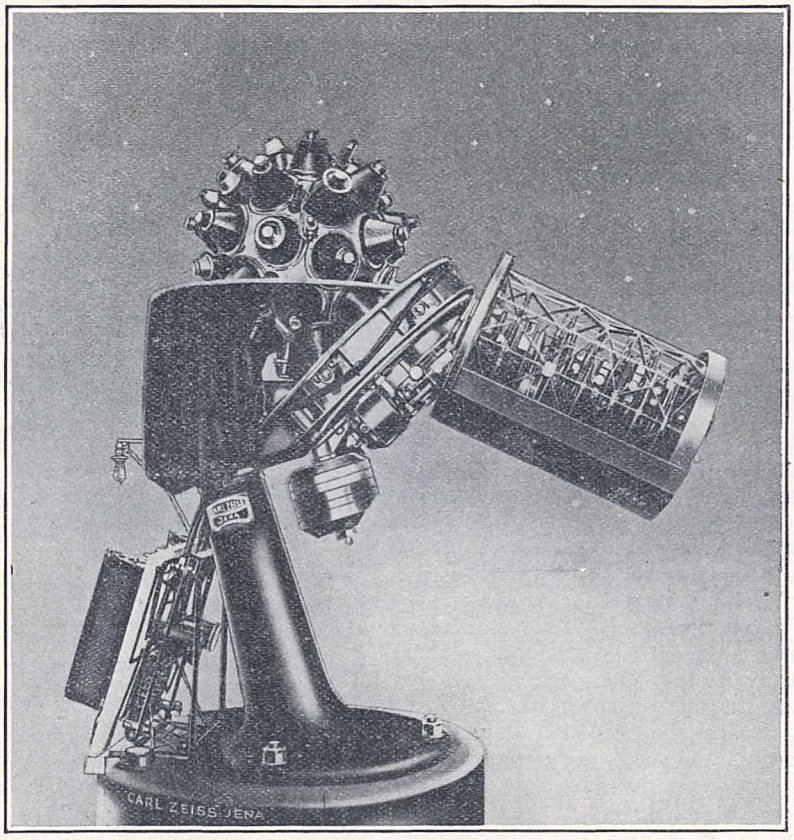

FIG. 2.—Projection apparatus.

The foregoing is a brief description of an instrument which probably represents the most successful attempt yet made to picture the heavenly motions. Its designer apparently claims that it is valuable as an astronomical work of precision. Some astronomers might possibly not feel inclined to lend unqualified assent to this claim, but few will deny the educational value of the apparatus, and there can scarcely be any doubt that the public at Munich and elsewhere will show their appreciation of the brilliant and successful efforts of all who have been concerned in the design and erection of this beautiful device.

Radio Communications.[1]

By Senatore G. MARCONI.

I HAVE always attached considerable importance to the problem of a practical directive system of radio communication. During my earliest experiments carried out in England more than twenty-eight years ago, I was able to show the transmission and reception of intelligible signals over a distance of 1¾ miles by means of an elementary beam system employing very short waves and reflectors, whilst, curiously enough, by means of the antenna or elevated wire system, utilising much longer waves, I could only at that time get results over a distance of half a mile.

The progress made with the non-directional long wave system was, however, so rapid and the results so immediately applicable to practical purposes, that it very soon became, and still remains, what might be called the standard system. It is regrettable that the study of short waves was neglected for a long period of years, for these waves, which, so far, are the only ones that can be confined to narrow beams, are also capable of being employed to give practical results unobtainable by the lower frequency system, which, up to now, has held the field for long-distance communication.

When during the War in 1916 I took up the systematic study of short waves, considerable doubt existed in my mind, and in that of other workers, as to whether the range of these waves might not prove to be too small for practical and useful purposes, particularly during daytime, if they might not be altogether too untrustworthy, and also as to whether large stretches of land, and particularly mountains, would not present absolute obstacles to their transmission over long distances.

In 1920 experiments were carried out by Capt. H. J. Round with duplex telephony on a 100-metre wave between Chelmsford and Southend, and the experiments were so successful that early in 1921 two stations which had been erected at Southwold and Zandvoord on the Dutch coast were put into commission experimentally, Southwold station utilising about 1 kilowatt to the aerial. Experiments were carried out, transmitting from these two stations to Norway in August 1921, and at Christiansund day and night telephony was easily received from both stations. At Christiania, about 700 English miles distant, very loud and constant signals were received during the hours of darkness and in the daytime on certain days, apparently when the barometer was low.

During these experiments the curious night distortion of telephone signals was discovered, particularly when transmission was overland, the major cause of which has more recently been discovered by Capt. Round in his work on broadcasting. Later, the results of these tests were merged into the general short-wave beam experiments.

During the tests carried out on the steam yacht *Elettra* in the spring and summer of 1923, I was able to discover that the short wave I was then using could not only cover great distances by day, and much greater distances by night, but that it was also quite trustworthy and that, moreover, large parts of continents and ranges of mountains did not materially reduce their working distance.

A series of tests was for the first time carried out with short waves over what might be termed world-wide distances during the winter, spring, and summer of this year, between Poldhu in Cornwall and receiving stations situated on ships at sea and also at such places as Montreal, New York, Rio de Janeiro, Buenos Ayres, and Sydney (New South Wales, Australia). All these tests proved to be successful, including the first telephonic communication with Australia ever realised, although the amount of power utilised at the sending station never exceeded 20 kilowatts. Very strong signals were obtained at all these places during the hours when darkness extended over the whole distance separating each of them from Poldhu, and weaker signals for a few hours when the sun was about the horizon at either end, the intensity of the signals varying inversely in proportion to the mean altitude of the sun when above the horizon. Although the signals were received with great strength at New York, Rio, and Buenos Ayres during the time when darkness spread over the whole or at least the major part of the great circle track separating these places from Poldhu, no signals at all were ever received, during these tests, when the same track or part of space was all, or substantially all, illuminated by the light of the sun.

While this limitation of the period of working to practically the hours of darkness constituted an undoubted disadvantage, still the economical advantages, together with the trustworthiness and possibility of working this system at far greater speeds than would have been feasible with the well-known high-powered long-wave installations, went far to convince me that the short-wave beam system would be capable of transmitting a far greater number of words per 24 hours between England and far-distant countries, such as Australia, than would be possible by the comparatively powerful, cumbersome, and expensive stations actually in use, or which were planned to be used, for Imperial commercial communications. It is a satisfaction to me to be able to state that the stations intended for this purpose in England and others to be installed in the principal Dominions and far-distant countries will all be on the beam system.

Commencing in August of this year, a further series of investigations was carried out between Poldhu and the yacht *Elettra*, the object being to endeavour, if possible, to find means of overcoming the limitation of working hours brought about by daylight, and also to test whether the effect of the reflectors would give the expected increase of signal strength over long distances. The yacht proceeded to Spain, then to Madeira, and afterwards to Italy. From Naples we sailed for Beyruth in Syria, touching at Messina and Crete, returning to Naples via Athens.

At Madeira it was ascertained that a reflector at the transmitting station increased the strength of the received signals in accordance with our calculations, but that, notwithstanding this increase of strength, when using a 92-metre wave, the daylight range was

[1] From the inaugural address to the Royal Society of Arts delivered on December 11.

only very slightly augmented. Comparative tests were carefully carried out with waves of 92, 60, 47, and 32 metres also at other places in the Atlantic and Mediterranean.

These tests enabled us to discover that the daylight range of practical communication over long distances increased very rapidly as the wave-length was reduced, the 32-metre wave being regularly received all day at Beyruth, whilst the 92-metre wave failed to reveal itself for many hours each day even at Madeira, notwithstanding the fact that the distance between Poldhu and Madeira is 1100 miles, entirely over sea, whilst that between Poldhu and Beyruth is 2100 miles, practically all over mountainous land. Our observations went to confirm the fact that for waves between 100 metres and 32 metres the daylight absorption decreased very rapidly with the shortening of wave-length.

These results were so interesting and satisfactory that I immediately decided to try further tests over much greater distances. In October of this year, transmission experiments were carried out on a 32-metre wave from Poldhu to specially installed receivers at Montreal, New York, Rio, Buenos Ayres, and Sydney (Australia). Although the available power utilised at Poldhu was only 12 kilowatts, it was at once found possible to transmit signals and messages to New York, Rio, and Buenos Ayres when the whole of the great circle track separating these places from Poldhu was exposed to daylight. During a complete day transmission at fixed intervals carried out last October with Sydney, New South Wales, that station received the Poldhu signals for 23½ hours out of the 24, and a 48-hour test which was only completed on December 10 fully confirmed the result.

The tests from England to places situated south of the equator, such as Sydney, Buenos Ayres, Rio de Janeiro, and Cape Town, are particularly interesting for the reason that the waves have always in these cases to traverse what may be called a summer zone. They are therefore subjected to an averaging effect of conditions, which can never possibly exist when the transmissions take place only between stations situated in the northern or southern hemispheres. During November some successful receiving tests were carried out in England, from a low power transmitting station in Australia utilising waves of 87 metres. During the present month of December, trials have been continued with Canada, the United States, Brazil, the Argentine, and Australia, and also, for the first time, with Bombay and Karachi in India and Cape Town in South Africa. The power utilised at the Poldhu station during all these tests was 15 kilowatts.

The results have fully confirmed my expectations in regard to the behaviour of the various wave-lengths over such great distances, and I have no doubt that the information gained will render possible the installation of comparatively low power stations capable of establishing and maintaining commercial services by day and by night between England and the most distant parts of the globe.

The low cost of this system both in capital and running expenses, compared with that of the existing type of stations, must prove to be very great, and should bring about the possibility of a reduction in telegraph rates for all long-distance communications, besides making direct communication with some of the smaller outposts of the Empire commercially remunerative. Already the size and power of some of the most modern long-wave stations was becoming a serious question from a financial point of view. The newly equipped station at Buenos Ayres, for example, which was designed primarily for communicating with Europe over a distance of about 6000 miles, employs 800 kilowatts and an aerial supported by ten towers, each 680 feet high. This station usually works on wave-lengths of about 12,000 and 16,000 metres. Another example is the British Post Office station which is being erected near Rugby, which, when completed, will employ 1000 kilowatts and an aerial supported by 16 towers, each 820 feet high, while the station being erected in the Union of South Africa was designed on a similar gigantic scale.

I am now firmly convinced that the beam stations employing only a small fraction of this power and much lower and fewer masts will be able to communicate at practically any time with any part of the Empire, and I cannot refrain from expressing my strong personal opinion that these powerful long-wave stations will soon be found to be uneconomical and comparatively inefficient in so far as long-distance commercial communications are concerned. Although we have, or believe we have, all the necessary data for the generation, radiation, and reception of electrical waves, as at present utilised for long-distance communications, we are still far from possessing anything approaching an exact knowledge of the conditions governing the propagation of these waves through space. These results indicate quite definitely that the well-known Austin formula is inapplicable to these waves. Another formula will have to be devised, based on the results of further investigations.

Reflectors of practical and economical dimensions are only efficiently applicable when short waves are used, and, although very long distances have been covered by these waves without the use of directional devices, I am convinced that these will be found to be essential for ensuring the carrying out of commercial high speed services. The disadvantageous effect called "fading" is sometimes a source of serious trouble when receiving signals transmitted by means of short waves, although much less serious than when waves of several hundred metres in length are employed. According to our experience, the use of reflectors diminishes fading, and also tends to overcome its effects by enormously increasing the strength and therefore the margin of readability of the received signals.

Increasingly large and expensive reflectors could, of course, be used with longer waves than 100 metres, but the results of all recent tests seem to indicate that the shorter waves present the greatest advantages, one of the most important being that their reception is very much less liable to interference by the effects of atmospheric electrical disturbances, or "X's."

If these waves are destined to carry a considerable part of the most important long-distance telegraphic traffic of the world, it may well be necessary in the near future, by international legislation, to regulate their use and safeguard them from preventable interference.

The Leeds University Celebrations.

DISTINGUISHED representatives of universities throughout the British Empire and of learned societies and professional bodies gathered together at Leeds during last week to join with local bodies in congratulating the University of Leeds on the attainment of its majority—an event which coincides with the jubilee of the parent institution, the Yorkshire College of Science. In the course of a series of important ceremonies spread over the whole week, the outstanding events were the sermon preached by the Archbishop of York in the Parish Church, Lord Balfour's great speech at the University dinner, the eloquent words with which Sir Michael Sadler reviewed the University's history, the addresses delivered by delegates at the official reception, and Sir Berkeley Moynihan's brilliant survey of the record of surgery in Leeds.

The wide and influential response to the invitation to participate in these celebrations is a tribute to the success which has attended the efforts of this young University. But it is not in this fact that the real significance of the gathering is to be found. Rather is it to be taken, first, as a demonstration of that fellowship within the world of learning which, important in its direct help to the advance of knowledge, may also exert a profound influence in producing a better understanding between the peoples of different countries; and, second, as evidence of the general recognition of the fact that of all the progress which has been made in education during the last fifty years, nothing has been so remarkable as the growth of the modern universities. Of this growth, the University of Leeds provides a good example, and it is perhaps to this more than anything that is due the representative character of last week's brilliant assembly.

The Yorkshire College of Science opened its doors on October 26, 1874, as the result of the efforts of a Yorkshire Board of Education the purpose of which was to bring about the development of scientific instruction in the county. The ground had been prepared for this new venture by the work of the Mechanics' Institutes, the formation of science classes, and the growing opinion in favour of scientific training as an aid to industry. Sir Michael Sadler puts forward the view that the aims of the promoters of the College were not so narrowly utilitarian as has generally been supposed, believing that they had in their minds a larger view of the purposes of the College than they thought it necessary to disclose. Their arguments were mainly based, however, on the industrial needs of the country, and they defined the objects of the College as being "to supply instruction in those sciences which are applicable to the Manufactures, Engineering, Mining, and Agriculture, of the County of York, also in such arts and languages as are cognate to the foregoing purpose." But, even if their aim was wholly utilitarian, it seems unnecessary to seek excuses for them. They were without question pioneers whose ideas were well in advance of general opinion, and their efforts achieved a notable development in higher education. Some there were who felt at the time of the establishment of the College that it was being confined within unduly narrow limits. Amongst these was Dr. Lyon Playfair, than whom the College could have had no more competent adviser. Lord Frederick Cavendish, the president of the College, was also emphatic in urging the avoidance of a one-sided concern. It is clear, therefore, that, whatever may have been the opinion of the general body of promoters, there was influential and expert support for the opinion expressed in the columns of NATURE on October 14, 1875: "If the County is as earnest in furthering its welfare as we believe it to be, the institution ought not to remain long on its present limited basis."

The widening of the curriculum of the College came about very quickly, and the cause of it was not primarily the pressure of outside opinion but the demand from within, coming both from the professors who were appointed to teach science and from the students who were in attendance for the purpose of studying science. Both staff and students found the need for literary studies if their work was to secure its best results. Some credit for the development must be given also to the external examinations of the University of London, which demanded a wider range of knowledge than could be gained within the early curriculum of the College. It was the work of the Cambridge University Extension Lectures scheme which made possible, only three years after the beginning of the College, the addition of literary and historical subjects to its courses of study. The College took over the work of the Extension Committee in 1877 and, in the following year, renamed itself "The Yorkshire College." In 1884 the Yorkshire College joined forces with the Leeds School of Medicine (which had been at work since 1831), and three years later attained university status by admission into the Victoria University. In 1904, having unsuccessfully opposed the dissolution of this Federal University, the Yorkshire College secured an independent Charter as "The University of Leeds."

Perhaps the most remarkable thing about the history of the Yorkshire College and the University of Leeds is the fact that from its very beginning until the present day its growth has continued without cessation. In this it has more than kept pace with the development of public opinion in favour of university education and with the realisation of the value of scientific research. Its governing body, constituted on a representative basis, has been able to retain its independence while accepting large sums of money from the State and the Local Authorities, and from other contributing bodies. This position (not maintained without certain struggles) has enabled the University to develop in a way which would scarcely have been possible under restrictions imposed by external authority. The University has attached more importance to staffing than to buildings, and, though it may have suffered in appearance, its policy has been more than justified by its results. Served by men and women of distinction, performing work of high value, and having the advantage and the dignity of self-government, the University has attracted to its governing body men of great business capacity, and its affairs have always been managed with efficiency.

The congratulations which have been showered upon the University of Leeds on the occasion of its jubilee indicate the general satisfaction of sister institutions and the public with the manner in which a College

founded on unambitious lines has grown in the space of fifty years into a University with nearly 2000 students and a staff of 268, constantly widening its range of studies, developing a strong Faculty of Arts while maintaining the distinction of its scientific work, retaining through all this expansion the atmosphere of friendliness in which it justifiably takes pride, and meeting its financial obligations in face of an annual expenditure increased in the space of six years from 70,000*l.* to 173,000*l.*

The University of Leeds is also entitled to congratulation for its present resolve to continue its progress in spite of the severe financial difficulties which stand in the way. It has set itself the great task of providing buildings worthy of its high purpose and of enlarging its endowment for scientific research. The purpose is one which deserves and will no doubt receive general commendation, and our best wish for the University is that its present enterprise will be crowned with a success equal to its past achievements.

Obituary.

PROF. IAROSLAV HLAVA.

WITHIN recent times the Czechoslovak nation has suffered several losses of eminent professors of its Charles' (Bohemian) University, which have been recorded in NATURE. Prof. Iaroslav Hlava died in Prague in his seventieth year on November 1. Prof. Hlava was the senior of the medical faculty and its eminent, most representative member. He was professor of pathological anatomy and of bacteriology, but he had to establish the chair of that science for our nation, for up to the year 1882 it was represented only by German professors. He began his career as a demonstrator of Prof. Klebs in Prague and then studied under Conheim, Weigert, Wirchow, Recklingshausen, Cornil, Vulpian, and Stricker.

Hlava became in 1884 associate professor, and in 1887 ordinary professor; later he was dean of the faculty, and in 1906 Rector Magnificus of our University. He was a great teacher of pathological anatomy. But he was also a well-known scientific investigator, and the number of his scientific discoveries and publications is too great to be mentioned here in detail. The principal object of his investigations were the infectious diseases, the modern teaching of which celebrated its triumphs at a time when Hlava was a young man. Bacteriology was in our country closely connected with his name. His special study was that of exanthemata, especially of scarlatina and of exanthemic typhoid fever, but this investigation proceeded very slowly, owing to the scarcity of this disease, and was brought to a close only during the War. His other investigations covered histology, epidemiology, and parasitology.

Hlava published most of his papers in the Bohemian language, and established for this purpose a special Collective Journal. To every paper a French résumé was added, and so Hlava's work became known in foreign countries. How it was appreciated there is evident from the great interest by which his numerous papers were received at different scientific congresses, especially French, Russian, Polish, and Jugoslav. A proof of it is given by the fact that he was not only a member of Bohemian learned societies like the Bohemian Academy of Sciences, and president of our Medical Society and of the High Sanitary Council, but also president of the Bohemian national committee at many scientific congresses, and foreign associate of the Academy of Medicine in Paris, member of the military Medical Academy of Petrograd, and a number of other medical societies in various countries. He received three high Serbian decorations. The imposing monument which exists in his wonderfully up-to-date Pathological Institute (called Hlava's Institute) will be a permanent symbol of his scientific significance.

BOHUSLAV BRAUNER.

CAMBRIDGE mourns the death, on December 7, of Richard Irwin Lynch, who for forty years was Curator of the University Botanic Garden. Mr. Lynch was born at St. Germans, Cornwall, in 1850, and went to Kew at the age of seventeen. He rose to the position of senior foreman, which he held until 1879, when he came to Cambridge. Of his many publications, all written in a fresh and charming style, perhaps the best known is his book on Iris. He is also well known by the Cineraria and Gerbera hybrids he raised. The University gave him an honorary degree of M.A. in 1906, and in the same year he received the Victorian Medal for Horticulture from the Royal Horticultural Society. In 1923 he received the Veitch medal inscribed "To R. Irwin Lynch for his work in Horticulture." He was an accurate botanist and an assiduous collector, and few of the present generation know how much Cambridge owes to him. On his retirement in 1919 he went to live at Torquay, a move deeply regretted by his numerous friends in Cambridge, who would have enjoyed his companionship, and been glad of his help and advice about everything to do with gardening.

H. G.-C.

WE regret to announce the following deaths:

Prof. Hugo von Seeliger, professor of astronomy and director of the observatory at Munich, and formerly president of the Bavarian Academy of Sciences, on December 2, aged seventy-five.

Dr. Otto Pufahl, professor of metallurgy in the mining department of the Berlin Technische Hochschule, on November 18, aged seventy.

Dr. Carlo De Stefani, professor of geology and physical geography in the Royal University of Florence, on December 12.

M. Eugène Simon, correspondant of the Paris Academy of Sciences in the section of anatomy and zoology, and author of the "Histoire naturelle des Araignées," on November 17, aged seventy-six.

Dr. Felix Tannhäuser, extra-ordinary professor of mineralogy and geology at the Technische Hochschule and the University of Berlin, on December 2.

Current Topics and Events

IN the Rationalist Press Association Annual for 1925 there is an interesting and suggestive article by Sir Arthur Keith on "Capital as a factor in Evolution." The gist of it is that we see in the biological order a closely similar use of saving for the purpose of higher development to that which we see in the sociological order in the use of capital. Sir Arthur develops the argument in considerable detail both in the case of the fowl, where the yolk-saving habit is carried to a very high point, and also in that group of fishes which lie near the ancestral line of the higher vertebrates, namely, the Selachians (sharks, rays and dog-fish). The argument is a continuation of Francis Balfour's discovery of forty years ago that the key to many of the obscure problems surrounding the development of the higher vertebrates may be found by studying the embryology of the Selachians. This is specially true of the structures which allow the young to draw their nourishment from the womb of the mother. The placenta is the most wonderful of these devices gradually developed. In the case of man it is just in the later intra-uterine period that the new and characteristic features of the brain and body are invented and worked out. We may then fairly continue the argument to the period of dependence prolonged after birth and after childhood. Only capital, that is saving, makes this possible. Knowledge is absorbed and increased owing to the shelter and the leisure provided by capital. This is, of course, only one aspect of the case for capitalism, but for those who care first for the intellectual stability and progress of mankind it is perhaps the most important: it is unfortunately the most easily overlooked by the Communists either of Russia or anywhere else.

AT a meeting of the Institution of Electrical Engineers on December 18, Mr. Donald Murray gave a very interesting forecast of the telegraphy of the future. It is common knowledge that the present system of telegraphy is far from satisfactory. Telegraph lines could be loaded to many times their present capacity without any change being necessary; the delays occur at the sending and receiving ends. Mr. Murray points out that if printing transmitters and receivers were installed in each user's office or home, it would be possible for him by means of automatic exchanges to receive or to send long printed messages over any distance in a few minutes. The method is past the experimental stage. The British Post Office has received and transmitted printed messages over considerable distances for several years. The introduction of automatic telegraph exchanges is merely a question of time. In the new telegraphy any ordinary typist working at from 40 to 80 words a minute could send the message which would be received in full printed form in a few minutes' time, no matter how great the distance between the sender and the receiver. The main obstacle in the path of progress is the price of the teletype machines, but once the demand increased to tens of thousands there is no reason to suppose that the price would be appreciably greater than that of a good typewriter. A probable development would be the broadcasting of printed news by a teletype receiver which could be actuated through the ordinary telephone wire. The use of the teletype printer will shortly take place in the United States, as both the Western Union and the Bell Telephone Co. are offering facilities to business men. The continually extending use of automatic telephones and telegraphs will gradually reduce the number of telephone girls and telegraph operators. Another effect will be to speed up to the utmost limit the rate at which business men work.

IN the account of the experiences of the Mount Everest expedition which appears in the December number of the *Geographical Journal*, Mr. N. E. Odell, who climbed to nearly 27,000 ft., makes some important observations with regard to the use of oxygen at high altitudes. He believes that if a man has been acclimatised at altitudes of say 22,000 or 23,000 ft., he can do without oxygen. Furthermore, he thinks that oxygen used liberally may be regarded as a source of danger by preventing the user from proper acclimatisation, and greatly increasing the chances of his collapse if the apparatus breaks down. The weight of the present apparatus, about 30 lb., combined with its bulk, obviates any advantage to be gained from it. Mr. Odell records the interesting physiological fact that all members of the recent expedition who had served in previous attempts acclimatised quicker than new-comers. He concludes by stating his belief that Mount Everest can be climbed without oxygen, and that if a high climbing party carries it in future, it should only be in small quantities, as an emergency measure, and must be contained in much lighter apparatus. Articles by other members of the expedition give a full account of the attempt on the summit, and are illustrated by a number of beautiful photographic plates.

THREE recent papers on the laws governing population growth were discussed by Dr. T. H. C. Stevenson, of the General Register Office, at a meeting of the Royal Statistical Society held on December 16. Dr. Stevenson stated that the birth-rate for Europe as a whole, which during the nineteenth century, so far as covered by the official records, had not varied very greatly, took a sudden downward plunge with the advent of the 20th, and continued to fall, at an accelerating pace, until the outbreak of war in 1914 spoilt the comparison. Germany was much more affected by this movement than England and Wales, where the birth-rate decline during the fourteen years before the war had been very similar to that of Europe generally. This fact might have contributed towards fixing the date for putting Germany's war machine in motion. If the death-rate had varied without reference to population conditions, and in the opening years of the present century, the birth-rate also, this would make the future course of population all the

more difficult to prognosticate. The very suddenness of the change suggests interference with the laws of Nature, as by increased practice of contraception, rather than a change in the laws of Nature themselves.

THE Natal Museum has issued two series of pictorial post-cards, ten in each series, illustrating the mammals of South Africa. They represent photographs of natural groups set up in the Museum and, as the groups have been mounted in natural attitudes and arranged amidst surroundings representing as closely as possible the special habitat of each species, the cards provide an excellent series of illustrations of the characteristic mammalian fauna of South Africa, mainly antelopes, but including elephant, rhinoceros, zebra, and lion. They are very pleasingly reproduced and of considerable artistic merit, and are, at the same time, an eloquent tribute to the fine work which is being done at the Natal Museum. With each series is issued a leaflet in which a reasoned plea is made for the international protection of the African fauna. The cards, by showing the reader of the pamphlet the beauty of what he is asked to protect, should be very helpful propaganda in enlisting practical support for the cause which Dr. Warren, as indeed all naturalists, has at heart. It is to be hoped that the series of cards will be extended to other groups of animals, for they must prove of great educational value as an aid to the teaching of natural history in the schools of South Africa.

DR. JOHANNES BÜTTIKOFER, director of the Zoological Garden at Rotterdam, has been elected a foreign member of the Zoological Society of London.

THE Foulerton Award of the Geologists' Association will be presented to Mr. A. L. Leach at the annual general meeting to be held next February. Mr. Leach was honorary secretary of the Association for the period 1913–1918.

THE Aerodynamics Experimental Department of the Royal Aircraft Establishments requires a number of test assistants. Applicants must have had technical training to the standard of a degree in natural science or engineering, and be willing and medically fit to fly as observers. Applications, marked A. 43, should be sent to the Superintendent, R.A.E., South Farnborough, Hants.

PROF. C. VERNON BOYS has been awarded the second Duddell Memorial Medal by the Council of the Physical Society of London. According to the terms of the Duddell Memorial Trust, the award is "for the advancement of knowledge by the invention or design of scientific instruments or by the discovery of materials used in their construction." The award to Prof. Boys was by a unanimous decision of the Council.

THE Safety in Mines Research Board requires the services for a year of an investigator to carry out work on the strengths of various structures for the support of underground workings in coal-mines. The possession of a university degree or its equivalent in engineering is a necessity. Forms of application, returnable not later than December 31, can be obtained from the Under-Secretary for Mines, Establishment Branch, Mines Department, Dean Stanley Street, S.W.1.

DR. F. P. STOWELL has been elected as the first Aquarium Research Fellow of the Zoological Society of London. Dr. Stowell is a graduate of the University of Liverpool, where he has been carrying out research in chemistry. The Fellowship, which is tenable for 3 years, is of the value of 350*l.* a year, and has been established for the investigation of the conditions affecting aquatic life in fresh and salt water aquaria. There were twenty candidates for the Fellowship.

APPLICATIONS are invited by the London School of Hygiene and Tropical Medicine (Division of Tropical Medicine and Hygiene) for the post of assistant in helminthology. Candidates must hold a science degree and be qualified in medicine or veterinary medicine. Applications, with particulars of candidates' experience and research, copies of their scientific contributions, and the names of not more than three referees, must be received by, at latest, January 1, by the Secretary of the School, Malet Street, W.C.1.

THE Harrison Memorial Prize selection committee announces that it is unable to make an award of the Harrison Memorial Prize for 1924. According to the terms of the trust deed, the award is in the hands of a committee consisting of the presidents of the Chemical Society, the Institute of Chemistry, the Society of Chemical Industry, and the Pharmaceutical Society, and is given "for the most meritorious and promising original investigations in any branch of pure or applied chemistry" of the previous five years.

THOSE who have contributed to the proposed memorial to the late Dr. and Mrs. Augustus D. Waller will be glad to know that the sum of 2000*l.* has been subscribed towards the memorial at the London (Royal Free Hospital) School of Medicine for Women, and a trust deed has been drawn up embodying the resolutions of the final meeting of the Committee and subscribers held on July 17 last. The money has been handed over to the Council of the Medical School; it is being invested as a capital sum, and the interest will be applied for purposes of scientific research. The sum of about 105*l.* has so far been subscribed for the proposed memorial of a Waller Research Room at St. Mary's Hospital. If the scheme does not materialise in a year, the donors will be consulted as to the use of their money. A complete list of subscribers has now been prepared.

CATALOGUE E issued by Messrs. Flatters and Garnett, Ltd., 309 Oxford Road, Manchester, lists the lantern slides which that firm has available for purchase or hire. It consists of no less than 100 closely printed pages with a few representative

reproductions, and includes a wealth of subjects, mainly of a natural history type. The slides showing various plant associations should be particularly useful. There are numerous slides illustrating technical features of botanical, geological, zoological, and related specimens, while sections of the catalogue are also devoted to astronomy, textile fibres and machinery, and so on. A useful index to the subject matter concludes the pamphlet.

A BIBLIOGRAPHY of meteorological literature prepared by the Royal Meteorological Society with the collaboration of the Meteorological Office, Air Ministry, No. 6, has recently been issued by the Royal Meteorological Society. The bibliography is now published in six-monthly parts; prior to 1921 it formed a part of the Society's Quarterly Journal. The publication is of great value to meteorologists in different parts of the globe, especially as the science of the weather is now making such rapid advances; it helps the inquirer to sort out literature on the branch of work with which he is interested. The divisions deal with the physics of the atmosphere, the upper air, and with more ordinary topics such as temperature, rain, wind, atmospheric electricity, and weather forecasting.

THE Institution of Heating and Ventilating Engineers is offering to assistants in the profession the following premiums: the Lumby, value 10*l.* 10*s.*, the Sirocco, value 10*l.* 10*s.*, and the Grenville, value 5*l.* 5*s.*, each carrying a medal of the institution. The Lumby premium will be for the best paper submitted dealing with, or any subject connected with, heating or hot-water supplies; the Sirocco premium for the best paper submitted dealing with ventilation and the general application of fans; air washing, air conditioning, dust and fume removal, mechanical draught, etc.; and the Grenville premium for the next best paper on any subject included in the above. Each competing essay must be written under a *nom de plume*, with the name and address of the sender in a separate sealed envelope, and be sent to reach the secretary of the Institution, 38 Victoria Street, S.W.1, not later than March 31 next. Further particulars are obtainable from the secretary.

Our Astronomical Column.

BRIGHTNESS OF PLANETS AND STARS. — The *Chaldaean* (vol. vi. No. 21) contains an interesting article by C. Schoch on the brightness of stars and planets at various distances. The most recent values of the planetary albedoes are employed. The earth seen from the moon is of mag. −16·6, but Mars seen from Phobos is −22·5, very little fainter than the sun seen from Jupiter, which is −23·2. The earth from Venus is −6·5, seven times as bright as Venus from the earth.

The brightest planet, seen from another planet, is Venus from Mercury, −7·7 mag., the earth from Venus coming next with −6·5. The moon from Venus is −2·4.

Of satellites seen from their primaries, our moon is very much the brightest, mag. −12·55; the two next brightest are Phobos from Mars −8·0, and Io from Jupiter −7·7. The table emphasises the fact of the great superiority of our moon as a light-giver, compared with the combined light of the satellites of the other planets, even if all could be full together.

The paper also gives the absolute magnitudes of several fixed stars. The three brightest are Deneb (α Cygni) −7·2, Rigel −5·8, Canopus −4·2, but as their parallaxes are very small, there is considerable uncertainty about these values.

THE DISTRIBUTION OF ENERGY IN STELLAR SPECTRA.—An interesting paper by Dr. C. G. Abbot on this subject appears in the *Astrophysical Journal*, vol. 60, p. 87. In place of the bolometer which he used in his earlier investigations of energy distribution, the author has employed a new type of radiometer, specially designed by Dr. E. F. Nichols for this type of work and used with the Mount Wilson 100-inch telescope arranged in the Coudé form. The deflexions were read visually on a phosphorescent scale placed 5 metres from the radiometer mirror. Observations were made in this way at fifteen different wave-lengths in the spectra of nine bright stars, and the results (reduced to normal conditions by comparison with solar observations) are given in diagrammatic form. It is interesting to note the very pronounced double maximum in the case of Rigel, and also the fact that Vega and Sirius (which are both of type Ao) show different energy distributions—the point of maximum, in particular, being very different in these two stars.

A tentative comparison is made of these curves with the theoretical "black-body" curves, and the diameters are computed of perfect radiators which would give emissions equal to those of the stars at the same temperatures. These diameters are found to compare favourably both with interferometer measures of stellar diameters and with Russell's theoretical values.

MECHANICAL ANALYSIS OF PERIODICITIES. — A problem of very frequent occurrence in astronomy is that of determining, from a set of observed values of a character (such as magnitude or radial velocity) which varies with time, the periodic time of variation. A mechanical method of solving the generalised problem has been applied by H. de Miffonis, and is described by him with detailed drawings in the *Astrophysical Journal*, vol. 60, p. 133. The principle underlying this instrument is to choose beforehand a definite length (*e.g.* 2 inches) to represent the required period, and then to alter the time scale of the observations by means of adjustable "time bars" until the period has the chosen length. The observations are represented by black dots on celluloid strips. Other dots are then arranged at intervals of two inches (in the time direction) on either side of the observation dots over the whole range of the instrument, and the time scale is adjusted by means of a hand wheel until these dots all lie as nearly as possible on a smooth curve.

The machine appears to be rather elaborate for its purpose unless a great amount of such work has to be done, but a useful description is added of a graphical method of solving such problems, involving the same principle, which can be used if the number of observations is insufficient to warrant the building of the machine as originally designed.

Research Items.

STONE IMPLEMENTS FROM TEXAS.—In the *Journal de la Société des Américanistes de Paris* (vol. xvi. N. Sér.), Dr. Chas. Peabody describes a number of implements of chipped flint from Kerrville, 120 kilometres north-west of San Antonio. There are in this area a large number of mounds of small dimensions varying from five to fifteen metres in diameter. So far as observed, these were not burial mounds and they usually occur along water-courses, particularly on a tongue of land between two streams. The specimens were obtained entirely from the surface. They include hammer stones; chipped axes with platforms usually covered with the original crust, varying from five to twenty centimetres in length, and very rough; arrow-heads with and without tangs; lance points, ceremonial and other, a few resembling Solutrean *feuilles de laurier*, with an occasional tendency to the sinuous edge and alternate retouching; knives, sometimes with flattened bases and stop-ridges for hafting, showing a striking similarity to Upper Palæolithic knives and scrapers. Among the scrapers, side scrapers are rare, but great ingenuity was shown in forming " snub-nosed " scrapers; while the long scrapers are identical with the *grattoirs carénés* of the Upper Palæolithic. Other forms were drills and spokeshaves. Flints are never found on the mounds, but lying near by. The patina is varied, generally blue or white. As Kerrville lies at the point of contact (at the beginning of historical times) of the Shoshoneans, Athapascans, and Coahuitlans, variety is to be expected, and it may be possible to establish the existence of trade and trade routes. To this the discovery of a piece of hæmatite, which is not known to occur in the neighbourhood, appears to point.

HUMAN MIGRATIONS.—An analysis of human migrations by Dr. Réné le Conte in the current issue of *Scientia* suggests a classification into those which are caused by violence and those which were carried out peaceably. Each class is capable of further subdivision. There are, for example, the armed movements of whole peoples in search of new land to cultivate or new lands for pasture, the latter to be distinguished from nomadism. Next military conquest, and, thirdly, military colonisation, to which the system of marches instituted by Charlemagne is closely related. A further class of migrations consists of the flight of families and individuals from a conqueror or invader. Peaceful migrations may consist of a peaceful penetration, usually mercantile, by land or sea, such as gave rise to Syracuse and Carthage. Permanent trans-oceanic migration is exclusively a feature of modern times. Temporary and seasonal migrations, though falling within the class of pacific migrations, have contributed nothing to the formation of peoples, as those who take part in them return to their own countries when once their object has been accomplished. Peaceful migrations are of more importance than the warlike, as is borne out by the fact that 250,000 Austrians landed in the United States in 1909–1910, as against 200,000 Wisigoths who crossed the Danube in A.D. 376.

ARABIC NUMERALS.—Dr. Karl Mischke, in an article in *Der Stein der Weisen*, Heft 14, in discussing the origin of the Arabic numerals, points out that the Roman numerals from 1 to 10 originated from the primitive custom of reckoning on the fingers of the two hands, and that it would be natural to assign the Arabic numerals to a similar origin. The Indian numerals do not at first sight appear to throw any light on the problem, but a comparison of archaic Indian forms found in early inscriptions with Chinese figures, which show less divergence from their original form, does suggest a derivation similar to that of the Roman numerals. Whereas, however, the Roman figures are based upon the fingers held in an upright position, in the archaic Indian and Chinese script they are regarded as held horizontally, one, two, and three being represented by a corresponding number of horizontal strokes, four by the clenched hand with the fingers held vertically, the back being towards the observer, and five by a side view of the clenched hand with the thumb uppermost. The remaining digits are formed on the analogy of the Roman numerals, $5+1$, $5+2$, and $5+5=10$, eight, however, being two fours, and nine, ten minus one. The rapidity in execution possible when a pen is substituted for the Chinese brush is responsible for the curved form of the 2, 3, 8, and 9 in the Indian script, while the Chinese retains an angular or only slightly curved form.

YELLOW FEVER IN NORTHERN BRAZIL.—While there was no reason to regard the yellow fever of Brazil as different from yellow fever occurring elsewhere, the micro-organism isolated from cases of the disease in Ecuador, Peru, and Mexico had not been experimentally demonstrated as the cause of Brazilian yellow fever. Indeed, two commissions, in 1919 and 1921, had failed to isolate the *Leptospira icteroides* from several cases studied in Bahia. A joint commission of American and Brazilian workers, therefore, proceeded to investigate the disease in Bahia in the latter part of 1923 and early part of 1924 (Hideyo Noguchi *et al.* in Monographs of the Rockefeller Institute for Medical Research, No. 20, August 1924). The commission succeeded in isolating two strains of Leptospira from two out of nine cases of yellow fever investigated, and these were proved by serological and other tests to be identical with the strains isolated elsewhere.

THE HAIR TRACTS OF MAMMALS.—Prof. F. Wood Jones (*Jour. Anat.*, vol. lix. pt. 1, pp. 72-82) puts forward some interesting views of the causation of hair tracts in mammals, including man. While not denying the efficacy of other theories on the question to account in part for the facts observed, he is of opinion that the most potent cause in the production of hair tracts is the animal's own peculiarities in the method of conducting the toilet of its coat. He bases his conclusions on the study of the habits of living marsupials and an examination of the tracts in embryos. He finds that the hair tracts, particularly the reversed or abnormal ones, coincide exactly with the direction in which the hair is combed during toilet operations, and he gives some very interesting observations on the way in which these operations are conducted and the specialisation of parts of the limbs for this purpose. He finds that the hair tracts of the adult, including the reversed tracts, are clearly shown in the embryo before it is able to influence the direction by scratching, and concludes that here there is a clear case of the inheritance of acquired characters, the whole complexity of reversals, whorls, and partings having been ingrained on the coat by the cumulative effects of the toilet methods of its ancestors. In this he supports and extends the views of Dr. Walter Kidd.

GEOLOGY OF SOUTH AUSTRALIA.—In the Trans. and Proc. of the Royal Society of South Australia, xlvii., 1923, Sir Douglas Mawson contributes two papers on the geology of the South Australian Highlands, including one on the igneous rocks of the northern

Flinders Range, in which he records a further occurrence of the primeval boulder clays belonging to the series now known as Adelaidean; they have been often regarded as Lower Cambrian, but are now generally assigned to the Upper pre-Cambrian. In a paper on part of the South Australian Highlands north of Adelaide, he confirms the discovery by Dr. E. O. Teale of another locality of Permo-Carboniferous glacial deposits. Dr. Howchin describes the sections along the eastern side of the Gulf of St. Vincent and accepts the view that the chief fossiliferous beds are Miocene, and not Eocene as held by Tate; he shows that the Miocene has been extensively faulted and is covered unconformably by the Pliocene.

STATISTICS OF OIL PRODUCTION.—Some interesting figures emerge from a perusal of a statistical report on petroleum production prepared by G. B. Richardson and others as a chapter of the Mineral Resources of the United States for 1922, issued last July. Up to the end of that year, the world's cumulative output of petroleum, reckoning from 1859 when Drake drilled his now classical oil-well in Pennsylvania, amounted to more than ten billion barrels. Of this colossal total, three countries together have contributed 90 per cent., namely, the United States (62·3), Russia (19·0), and Mexico (8·8). In the year under review the highest single year's output was obtained, 858,715,000 barrels constituting the world's production, this figure representing a 12 per cent. increase over the previous year (1921) and incidentally double the amount produced in 1914. During 1922 the United States produced nearly 560 million barrels of oil, due to the extraordinary flush output of the great fields of the Los Angeles Basin, California, those of the Mid-Continent and of the Gulf Coast regions; an increase of 18 per cent. over that country's production in 1921, this figure represented 65 per cent. of the world's total production for the same year, and 8 per cent. of the world's cumulative output since 1859. These figures throw a flood of light on the economic position of the industry during the years 1922 and 1923, which together have proved a period of extravagant over-production of petroleum resulting in a widespread slump in commercial activity, a serious depression from which the industry is only just showing signs of recovery. There is reason to believe that the figures for 1923, now just becoming available from authoritative sources, will eclipse those of 1922; these two years may well represent the peak of the world's production of oil, so that there is some ground for anticipating a gradual decline ultimately traceable from the current year. The other feature of 1922 worthy of note to British oil interests is that this was the year when Persia, by an output of 22,247,000 barrels, rose to fourth place on the list of producing countries; India came seventh with 8,529,000 barrels, Sarawak eleventh with 2,849,000 barrels, Trinidad next with 2,445,000 barrels, Canada nineteenth with 179,000 barrels, and England last with 1000 barrels. Finally, in this year the United States exported 136,000 barrels of domestic crude oil (not refined products) to England, and 361,000 barrels to Germany; the major export of crude oil went to Canada, which received 8,194,000 barrels.

HUMIDITY IN THE NETHERLAND INDIES.—In Verh. No. 8, vol. i., part 6 of the Publications of the Royal Magnetic and Meteorological Observatory of Batavia are published valuable results on relative humidity, tension of vapour, evaporation, and fog, discussed under the direction of Dr. C. Braak. The Dutch text gives much valuable data in considerable detail, and there is a brief English summary. At stations having no well-developed dry season, the mean monthly values of humidity range generally between 85 and 90 per cent. Relatively low monthly values occur at stations which have a well-developed dry season; the lowest monthly means occur mostly in September and range from 67 to 70 per cent. There is a great difference in the humidities at the high mountains of Java and those of Sumatra. The stations at the latter have a wet climate during the whole year, the lowest monthly average on Mt. Singgalang, in May, being 87 per cent., a value 17 per cent. above that on Mt. Pangerango in July. Considerable value is attached to wet bulb temperatures, and in Batavia when the wet bulb reading exceeds 26° C. the heat becomes troublesome. Evaporation is naturally much higher in the day than in the night; at many stations it is more than ten times as great, as a result of the relatively high wind velocity and the relatively low humidity. A chapter is given on dew and morning fog, and during prolonged drought dew is said to compensate partly for deficient rainfall. Dense haziness occurs in abnormally dry years, and in the eastern part of the Archipelago dense fog is sometimes experienced; 1902 is especially mentioned for the worst fog for thirty years. The fog was dry and the nights were without dew; on the east coast of Borneo high trees were not visible at a greater distance than 20 metres; dust is supposed to have taken some part in the phenomenon.

WHY WIRELESS WAVES BEND ROUND THE EARTH.—In the December issue of the *Philosophical Magazine*, Sir Joseph Larmor explains the bending of wireless waves round the earth as due to the presence in the upper atmosphere of electrons or light ions produced by the intense ultra-violet solar radiation (see also NATURE, November 1, p. 650). Such ions would increase the speed of propagation of wireless waves by an amount proportional to their number per c.c. and to the square of the wave-length of the waves. To provide the necessary curvature of the path of the radiation round the earth, only about 500 ions per c.c. out of the 10^{15} molecules per c.c. still present at a height of 50 miles from the earth's surface are necessary. Absorption of the radiation would take place at low altitudes owing to the presence of gas molecules, and in the upper regions according to the number of ions per c.c. There would be a layer in the upper atmosphere through which radiation would be transmitted with little absorption, and the energy shed down to the earth from this layer would allow the signals to be received at the surface.

CONTACT ELECTRICITY.—Messrs. A. Coehn and A. Cuss, in the *Zeitschrift für Physik* of October 28, describe a series of experiments to determine the charges produced by contact between metals and dielectrics, in a high vacuum. They show that by heating the substances employed, so as to drive off all moisture and adsorbed gas, the results can be reproduced with certainty, and that the charge depends (*a*) on the nature of the metal, its position in the Volta series, that is to say, its tendency to give off electrons; (*b*) on the power of the dielectric to take up positive metal ions. Mercury and the amalgams of the "noble" metals were charged positively in contact with all the dielectrics examined, which included diamond, quartz fused and crystalline, "felsenglas," sodium glass, ebonite, sealing-wax and amber. The amalgams of other metals were charged positively at low concentrations, the charge diminishing to zero as the amount of metal in the amalgam increased. For definite concentrations which differed for different dielectrics, the charges of the amalgams became negative, increasing as the amount of metal in the amalgam increased. With

diamond, even the amalgams of the alkali metals were positively charged for all concentrations. This implies that diamond in no circumstances takes up positive metallic ions.

DENDRITIC STRUCTURES IN CARBON STEELS.—In a cast steel, the elongation, reduction of area, and angle of bending are always smaller than in forged steel of the same composition. The material is rather brittle and will not resist an impulsive force. These defects are generally considered to be due mainly to the dendritic structure, which reveals itself by macro etching. The removal of this structure is an important process in the treatment of steel. It is usually done by forging and annealing, and therefore a considerably larger size of ingot is required than that actually used. If, however, the dendritic structure could be removed by a simple process of heat treatment, this would be a great benefit to the metallurgical world. The question has been investigated by Mr. Torajirô Ishiwara in a paper entitled "The Effect of Impurities on the Dendritic Structure in Carbon Steels and their Diffusion at High Temperatures" (Science Reports, Tohoku Imperial University, Series I. vol. xii. No. 4). He finds that the dendritic structure in ordinary carbon steel ingots is effaced at 100° or 200° below the liquidus line. This treatment, however, would spoil the material, since it would be badly overheated. It would appear, therefore, that mechanical work is really necessary. The author has found that quick cooling in the solidification interval favours the formation of dendrites in a steel ingot, and that carbon affects the crystallisation very little. Phosphorus has the most powerful effect of the other elements usually present, and, to a less extent, silicon and manganese. The minimum concentrations of these elements which make the ingots dendritic are nearly equal to the maximum amounts actually present in ordinary steels.

DIRECTION-FINDING BY RADIO. — The Radio Research Board is making an elaborate study of the variations of the apparent bearings of radio transmitting stations as determined by well-known radio methods of direction-finding. An account has recently been issued of the experiments which were carried out for the Board extending from February 1921 to March 1922. (Department of Scientific and Industrial Research: Radio Research Board. Special Report No. 2: Variations of apparent Bearings of Radio Transmitting Stations. Part 1: Observations on Fixed Stations, February 1921–March 1922. By Dr. R. L. Smith-Rose. Pp. x+96. (London: H.M. Stationery Office, 1924.) 3s. 6d. net.) A number of directional radio receiving sets were erected at universities or Government experimental stations in Britain. The sites chosen were on flat open ground, and so far as possible trees, metal work, and overhead wires were avoided. Regular observations were taken of the radio bearings of many transmitting stations, chiefly in Europe, the positions of which were accurately known. Many thousands of observations were taken, and Dr. R. L. Smith-Rose has summarised the results. Unfortunately, no very definite results beyond those which are already known can be deduced. While extreme variations exceeding 60° were observed when determining the direction of Moscow from Aberdeen, a distance of 1500 miles, almost equally large extreme variations were observed when determining from Bristol the direction of Poldhu. In all cases the variations were worst at night. The experiments were mostly confined to long waves having a range from 2000 to 9000 metres. In most cases also they passed over considerable tracts of land in some portion of their path. In an introduction, Mr. F. E. Smith points out that in the latter half of 1922 the investigation was extended to the comparatively short 450 metre wave which is used at present for commercial direction finding in Great Britain. It was possible with this wave-length to make experiments with waves that had passed entirely over sea. Under these conditions, comparatively satisfactory results were obtained at distances up to 100 miles, the maximum error being only a few degrees. We are looking forward with great interest to the further account of the experiments on short waves.

HYVAC OIL PUMP.—The Hyvac Two-stage Rotary Oil Pump (sold by W. Edwards and Co., 8a Allendale Road, Denmark Hill, S.E.5), in common with other rotary oil and "box" pumps, consists essentially of an eccentric steel cylinder rotating about a horizontal axis within a tank filled with oil of low vapour pressure. The inlet and outlet openings are close together, one on each side of a single sliding steel vane which moves in the cast-iron pump casing, and, by means of a spring, is caused to bear continuously against the outer surface of the inner cylinder. The latter in its eccentric motion serves to trap and expel a "parcel" of air in each revolution. The oil is sufficient to prevent leakage into the high vacuum. Two such units are mounted side by side on the same shaft and are connected in series—an arrangement which enables the pump to operate directly from atmospheric pressure down to pressures of the order of 1/1000 mm. mercury. The pump, which is American in origin, is small in size and readily portable. It is relatively silent in working, a feature appreciated by most workers with "box" pumps. The Hyvac pump, which marks, in our opinion, a real advance, is very suitable for furnishing a fore-vacuum for mercury vapour pumps. For its size it is rapid in action. Small discharge tubes can be exhausted in a few minutes, while in a test we find that so large a volume as 16 litres can be reduced from atmospheric pressure to 1/10 mm. in 30 minutes. The usual precautions must be taken. The oil must not be contaminated by water or organic vapours, or the performance will suffer. The gland about the main shaft may need very occasional attention, and the small leather non-return valve in the outlet of the first-stage unit should be renewed from time to time if the efficiency is to be maintained and if excessive leaking back of oil into the trap provided is to be avoided. If the driving belt from the motor (which is of slow speed and preferably English) is not kept tight, slipping may occur when starting up against atmospheric pressure.

BLUE ADSORPTION COMPOUNDS OF IODINE.—G. Barger and F. J. Eaton have carried the research on the blue adsorption compounds of iodine a stage further in a paper published in the Jour. Chem. Soc. for November. The constitutive and ionic influences on the formation of the various blue addition compounds with iodine are discussed. Substances having crossed conjugated double bonds (*e.g.* γ-pyrones) offer some of the best examples of the reaction; but it is now shown that many derivatives of 1 : 3 diketohydrindene do not react with iodine. The presence of a crossed conjugated double bond is not enough to ensure adsorption of iodine. The same remark applies to the bridge oxygen atom. The effect of hydrogen ion concentration on the adsorption is investigated by carrying out the adsorption in a phosphoric acid buffer solution. Wide variations in concentration of the phosphate ion affect neither the rapidity of formation of the blue complex nor its intensity. The main factor influencing the adsorption is probably molecular weight; it is probably not a constitutive factor, because compounds of the most diverse constitution are capable of giving a blue adsorption complex with iodine.

Cytology and Evolution.[1]

IT is now generally accepted as a fact that in cellular animals the control of their living activities, including the repetition of parental characters, resides in that specially highly evolved protoplasm known as chromatin. It has also been for many years realised that the behaviour of the chromosomes in mitosis—particularly their accurate longitudinal division—points to the linear arrangement of the different kinds of hereditary substance along the length of the chromosome. That this theoretical conclusion was accurate has been demonstrated beyond question by Morgan and his school. It has further been demonstrated that meiosis—the halving of the number of chromosomes in the gamete—is typically brought about by parasyndesis, the coming together of the homologous chromosomes in pairs. It is also the case that the two homologous chromosomes as they come together are similarly orientated: they are never "heads and tails."

These facts appear to justify certain important general conclusions.

(1) There exists an attractive force of a specific kind between particles of chromatin in the living cell. This is indicated (*a*) by the concentration of chromatin into chromosomes, and (*b*) by the approach of the chromosomes to one another in syndesis.

(2) The intensity of this attraction can be caused to vary by conditioning factors (*a*) of an extrinsic kind, as shown by the influence of radium on the gonad nuclei of Ascaris, and (*b*) of an intrinsic kind in the life of the cell; for example, the intensity increases during the prophases (shortening of chromosomes) and dies away in later phases of mitosis so as to be overborne in the case of the daughter chromosomes by the counter-attraction towards the centrosomes. This diminution in intensity is particularly marked in such a case as the somatic nuclei of early stages in the development of *Ascaris megalocephala*, where the chromosome loses its cohesion to the extent of fragmenting into numerous small particles.

(3) The intensity of attraction varies with the degree of likeness of the chromatin particles. This is indicated (*a*) by the localised clumping of chromatin at particular spots in the length of the chromosome ("chromomeres"), (*b*) by the coming together of *homologous* chromosomes in syndesis, and (*c*) by the fact that in parasyndesis corresponding portions of the two chromosomes come together.

[1] Abstract of an address delivered by Prof. J. Graham Kerr as retiring president of the Royal Philosophical Society of Glasgow (Biological Section), on October 10, 1924.

Natural Selection.

The view is taken that variability is to be regarded merely as a special case of the instability that is an inherent characteristic of all living substance, and therefore that it does not in itself call for special explanation. The idea that the hereditary substance (genes) is exempt from this general property, and stable and unvarying, is regarded as inherently improbable. Nature selects not variations of organs or other parts but whole individuals, according to their degree of "fitness" to their environmental conditions. As every individual is on one side or other of the normal line, the whole species is in direct touch with natural selection, not merely occasional individuals possessing some conspicuous abnormality of a particular organ, and there is therefore ample material for selection to work upon. It must not be forgotten that the selection of individuals showing a particular variation in detail necessarily involves the selection and consequent exaggeration of the *tendency* to develop that particular variation. This selection and intensification of tendency to vary in a particular direction has probably great directive influence in securing the continuity of evolutionary progress along definite lines.

The criticism that natural selection accounts only for adaptive features is now of greatly diminished importance. Certain features are known now to exist by mere chance; for example, the red colour of many deep-water marine animals. The advance of knowledge is constantly enlarging the number of features recognised as adaptive. Above all, it is now being realised far more fully how the various parts of the individual are shackled together by physiological relations through the internal medium of the body and in other ways, so that a small adaptive change in one organ is liable to carry with it correlated changes in other features of the body, possibly far more conspicuous and not in themselves adaptive.

Finally, it must be remembered that evolutionary adaptation to the environment has no natural term, for the elusive environment is in a state of continuous change in relation to the organism. Evolutionary change is a function (in the mathematical sense) of environmental change. Such change occurs in the environment itself—in the non-living environment—climatic or physiographical changes, or in the living environment—changes in the local fauna or flora; or, on the other hand, the active change may be on the part of the animal itself—such as change of habits from aquatic to terrestrial or aerial, from terrestrial to arboreal, from salt-water to fresh-water.

Progress in the Geological Survey of Great Britain.

THE Summary of Progress for 1923 of the Geological Survey of Great Britain and the Museum of Practical Geology[1] opens with the report of the Advisory Board. In this report we are reminded that in 1912 a Departmental Committee on the Science Museum and Geological Museum recommended the removal of the latter to a new building to be erected at South Kensington. The matter, shelved during the War, was not reopened until, in April 1923, the roof of the Geological Museum was found to be unsafe. It became necessary to close the Museum to the public, and later on to debar inquirers from access to the Survey offices, the Library, and the Map room. We now learn from the report that, on careful consideration of the position, the Government decided after the close of 1923 to erect a new museum and offices for the Geological Survey on the site recommended by the committee. Many will feel regret that a building and a situation with so many associations should be abandoned, but the advantages of the new site are manifest. The two great geological collections, one biologically arranged and illustrating stages in the evolution of life upon the globe, the other showing the forms of life which characterised each successive period in the history of the globe, will be side by side. It is to be expected also that adequate space will be provided not only for offices and workrooms, but also for the exhibition of minerals, rocks, and fossils now stored in drawers or overcrowded in exhibition

[1] Department of Scientific and Industrial Research. Summary of Progress of the Geological Survey of Great Britain and the Museum of Practical Geology for the Year 1923; with Report of the Geological Survey Board and Report of the Director. Pp. iv+173. (London: H.M. Stationery Office, 1924.) 4s. net.

cases. An overcrowded case produces a mere sense of bewilderment, and to say that some of the cases in the Jermyn Street Museum contain twice as many specimens as they can properly exhibit, is no overstatement.

From the Director's report, we learn that nine field-units have been engaged in carrying out the programme approved for the year. In the London district, surveying proceeded in the Romford map and was commenced in the country near Marlborough. But the bulk of the summary relates to re-examination of coal-fields and their surroundings. In the Midland district, the various subdivisions of the Upper Coal Measures, including the Enville Group, have been recognised in the Coalbrookdale coal-field. The rocks examined range from pre-Cambrian to Trias. In the Yorkshire and Lancashire districts, advantage is being taken of the remapping of the Millstone Grit to examine the marine fauna, the Goniatites in particular, with the view of establishing a zonal sequence, the want of which has been much felt. The work in Lancashire has lain chiefly near Rochdale. In the Yorkshire district, the information respecting boreholes and new sinkings in the "concealed coal-field" is being kept up-to-date with the idea of preparing a new edition of the memoir on that important investigation. In Cumberland the sequence of limestones in the Lower Carboniferous Series has been established and work has been begun on the east side of the Vale of Eden. The correlation of the same limestones is being studied in Northumberland also, and the mapping of the Scremerston Series and of the Shilbottle Coal is well advanced. In Scotland, the Edge Coals of the Carboniferous Limestone Series are of scarcely less importance than those of the Coal Measures. Their examination is proceeding in Fife, the Lothians, Stirlingshire, Ayrshire, and Lanark.

Among the publications of 1923, special mention must be made of four parts of the great monograph on Carboniferous plants by the late Dr. Kidston, a work which will be of high value all the world over. The memoir on the Concealed Mesozoic Rocks of Kent is another notable contribution to palæontology, as well as to the stratigraphy of the south-east of England.

Two remarkable maps, issued, among others, during the same year, are of the highest interest to all geologists. One, of the Assynt district, is a special map made up of parts of the four one-inch sheets, 101, 102, 107, 108; the other, Sheet 44, illustrates Mull and its surroundings. To do justice to the geology without obscuring the topography was scarcely possible on so small a scale, but both maps are remarkable examples of detailed mapping and skilful mechanical reproduction.

The memoir which has been issued on the country around Flint, Hawarden, and Caergwrle[2] gives the results of a re-survey which commenced in 1910. The area described extends from the Vale of Clwyd to the peninsula of Wirral and includes the southern part of the Flintshire Coal Field. Probably in no other part of Great Britain do the Lower Carboniferous rocks show more remarkable changes than between north and south Flintshire. They have not been re-surveyed and the identity of the Millstone Grit is still in doubt, but it may be expected that the fossils, when opportunity occurs of collecting them, will throw light on the correlation, especially when taken in conjunction with the zonal work in progress in Yorkshire. The folding and faulting of the region are of high interest and complicated. A long dissertation upon them, not easy to follow, forms the subject of Chapter ii.

The district which Mr. Osborne White describes in the Memoir on the Country near Brighton and Worthing[3] has been rendered classic by the labours of Mantell, Martin, and Dixon. The formations range in age from Wealden to London Clay, and in his account of them, Mr. White has added many observations of his own to the work of previous workers. Chapter vii., dealing with the superficial deposits, is of much interest. It contains detailed accounts of the raised beach and the overlying Coombe Rock, each of which is made the subject of suggestive speculations. A word must be said for the plates. All are good, but Plate 1, in particular, gives an admirable representation of the features of a broad landscape.

[2] "Memoirs of the Geological Survey: England and Wales. Explanation of Sheet 108: The Geology of the Country around Flint, Hawarden, and Caergwrle." By C. B. Wedd and W. B. R. King; with Contributions by G. W. Lamplugh, Dr. H. H. Thomas, W. C. Simmons and T. C. Cantrill. Pp. viii+222+6 plates. (Southampton: Ordnance Survey Office; London: E. Stanford, Ltd., 1924.) 6s. 6d. net.

[3] "Memoirs of the Geological Survey: England and Wales. Explanation of Sheets 318 and 333: The Geology of the Country near Brighton and Worthing." By H. J. Osborne White. Pp. vi+114+4 plates. (Southampton: Ordnance Survey Office; London: E. Stanford, Ltd., 1924.) 2s. 6d. net.

Research in Optics.

THE volume referred to below[1] contains a number of papers first published during the years 1921 and 1922 by the staff of the Optics Division of the National Physical Laboratory. They have already appeared separately in the publications of various societies and elsewhere, to which reference must be made for the several discussions. A casual reader would be likely to comment upon the diversity of the subjects which are dealt with, but doubtless this is to be explained as the result of the numerous problems which arose during the War. In spite of this diversity, the volume embodies several theoretical papers of considerable value which have received notice in the newer editions of the well-known books of Southall, Czapski, and others. Amongst these may be instanced the discussion of the classification of optical instruments (No. xvii.).

The experimental side of the work is also well represented. It is instructive to notice how the "principle of substitution" can be applied in refractometry, goniometry, and curvature measurements, for the enhancement of the accuracy of measurements, and though in many cases the methods described are available for use only in a highly equipped laboratory where measurements of precision are required, yet such methods as that described in the paper on the photometry of optical instruments should find a place in the practice of every optical workshop.

A brief notice such as the present is not the place for detailed criticism of papers the majority of which have been already discussed. Nevertheless, there are papers which only seem to point the way to a very much fuller treatment of the subject. In a paper on the position of best focus in the presence of spherical aberration, it is stated to be erroneous to suppose that "geometrical reasoning leads in a number of important practical problems to conclusions at variance with those which would be deduced directly from a wave theory of light propagation." The paper goes on to show that in the presence of simple spherical aberration, the points of greatest

[1] "The National Physical Laboratory. Collected Researches." Vol. 17. 1922. Pp. v+353. (London: H.M. Stationery Office, 1922.) 17s. 6d. net.

axial intensity of light (deduced by the wave theory on the basis of least variation of phase, and by a corpuscular or ray theory on the basis of the centre of gravity of axial ray intersections) would agree as estimated by these two theories. The paper does not show, however, that the point of greatest axial intensity is necessarily taken as the best focus when visual or photographic observation is made, and indeed nothing but experiment can settle such a question. Further, the "best focus" in geometrical optics has been universally assumed to be coincident with the circle of least confusion, which is far from the point of greatest axial intensity when spherical aberration is present. In fact, the present writer's experience has been that the statement quoted above is by no means so erroneous as the author of the paper referred to believes. There are many such questions in optics which cannot be settled by a short mathematical or geometrical discussion, and the paper thus indicates the necessity of a very much wider inquiry.

There is no doubt that the writers of these papers will face many problems of difficulty in the immediate future. Much is to be hoped from a collaboration of mathematician and experimenter in investigations which need the services of both. The production and use of non-spherical glass surfaces on a commercial scale for instrumental work is very largely waiting accomplishment, and there are other "major researches" quite worthy of the efforts of any workers. The staff of the National Physical Laboratory has, however, unique opportunities of getting into touch with industry, and aid will doubtless be given where it is most required.

Terrestrial Magnetism in France.

THE work referred to below[1] contains in twelve pages summaries of seismological and meteorological results at Parc St. Maur from 1915 to 1922. The remainder of the volume is devoted to terrestrial magnetism. The longest single article is one by the late M. C. Dufour, discussing the magnetic records of 1922 at the Observatory of Val Joyeux, of which he was in charge. M. Dufour's death in August 1923 is recorded with regret. Hourly values at Val Joyeux are confined to 6 h., 12 h., 18 h., and 24 h., except on the international quiet days, when all hours are included. The daily mean from the whole 24 hours and the general character are given, however, for each day. From 1921 to 1922 westerly declination, inclination, horizontal force, and vertical force all fell by 11′·1, 0′·4, 9γ, and 31γ respectively.

Papers by MM. Berthelot, Mathias, and others record the progress of the magnetic survey being prosecuted at present in France. It is explained that adequate financial provision has as yet been made only for the field-work. Mme. de Madinhac, one of the lady members of Prof. Maurain's staff, contributes a paper giving the values of the magnetic elements on January 1, 1921, in the chief places of each department of France. These are based on Angot's results for 1911, and on values of secular change derived after Angot's example from twelve observatories of Western Europe, which include Eskdalemuir, Greenwich, and Kew. A second lady member of the staff, Mlle. Homery, arrives in a similar fashion at corresponding results for North Africa, and also deals in a separate paper with results from 422 stations in Western and French Equatorial Africa. Charts for the epoch January 1, 1921, are given in each of these three papers. Even in the case of France the secular change data available do not appear altogether above suspicion, especially in the case of horizontal force and dip. M. Rohan Chabot deals with magnetic observations made during 1912–13 in an expedition to Angola and Rhodesia.

Work of a more theoretical character is represented by a calculation of the vertical electric current derived from a line integral of magnetic force round an area including the greater part of France. The direction found for the current is upwards, but the amplitude, 0·0043 ampere per square kilometre, is of the same order apparently as the probable error.

An interesting paper by M. C. E. Brazier discusses the relations between magnetic disturbance at Parc St. Maur and Val Joyeux and sunspot activity. For disturbance, use is made of an arbitrary scale due to Moureaux. The period 1884 to 1917 is divided into three 11-year periods, which are dealt with as a whole and separately. As has been found in England, disturbance shows a well-marked annual period. The spring maximum, near the end of March, exceeds the autumn maximum, which occurs early in October. At the end of the volume there are reproductions of the most disturbed curves of the year at Val Joyeux.

C. CHREE.

[1] "Annales de l'Institut de Physique du Globe de l'Université de Paris et du Bureau Central de Magnétisme terrestre," publiées par les soins de Ch. Maurain. Tome II. Quarto, pp. 146. Paris: Les Presses Universitaires de France, 1924.

Technical Education in Relation to Paper-making.

THE Board of Education has recently issued a report on technical education in England for the paper-making industry.[1] The report directs attention to the relatively small number of employees engaged in the manufacture of paper as compared with those of other trades such as engineering, textiles, iron and steel, but emphasises the point that the importance of the industry is probably enormously greater than the numbers employed would suggest, especially so where regard is paid to the uses of its products in commerce, education, and public administration.

Three points in the present development of the industry are important. These are:

(1) The development of the machines and other plant in use, so that the greater output is obtained at a less cost and a much increased speed. Up-to-date machinery is capable of producing paper such as "news," from a previously prepared pulp, in reels more than 200 in. wide, at a speed of more than 800 ft. per minute.

(2) Side by side there is a tendency towards larger mills and to the production of a particular paper for specific uses in any one mill.

(3) The gradual recognition of the aid which chemistry and engineering can render to the industry.

It would appear that the paper manufacturers of England are behind their American and continental competitors in their willingness to utilise the services of highly skilled specialists. The products of the English mills do not suffer in comparison with those of other countries, but if the future is to be secure, quality must be maintained and costs of production reduced. This can be accomplished only by attention to scientific methods and the systematic technical

[1] Board of Education: Report of H.M. Inspector on Technical Education in England for the Paper-making Industry. (London: H.M. Stationery Office, 1924.) 6d. net.

education of those engaged in the industry. The close co-operation of the engineer and chemist is essential. Encouragement is found in this direction in the formation of a technical section of the Paper-makers' Association, the aim of which is to foster the development of the industry along such lines.

Full-time courses of instruction in paper-making and allied subjects (chemistry, physics, etc.) are provided at the Manchester College of Technology. At the Battersea Polytechnic, London, such courses are also available, together with specialised instruction on the engineering side of the subject and on paper testing. Part-time courses (evening) are provided at these centres and at one or two other institutes.

The writer of the report has had the advantage of discussion with leading technologists connected with the industry, and makes recommendations concerning the further development of instruction by way of organised courses.

University and Educational Intelligence.

BIRMINGHAM.—The following doctorates have been awarded, the subjects of the theses being indicated in each case :—

D.Sc. (*Botany*), Mr. C. H. Gadd ("*Phytophthora Faberi*," and "The Swarming of Zoospores of *Phytophthora Faberi*," and other papers); (*Electrical Engineering*), Abdel Aziz Ahmed ("Theoretical and Experimental Study of the Electric Field in an Electrolytic Cell," "Variation of Magnetic Potential," "Investigation of Magnetic Leakage," and other papers). Ph.D. (*Biochemistry*), Mr. W. S. Shaw ("The Rôle of Silica and Phosphorus in Plant Growth and their Inter-Relations," and other papers); (*Civil Engineering*), Mr. H. V. Budgen ("Fatigue of Metals"); (*Electrical Engineering*), Mr. O. R. Randall ("The Behaviour of certain Semi-Conductors in Electric Circuits"); (*Metallurgy*), Mr. L. F. C. Northcott ("The Condition of Carbon in Iron").

CAMBRIDGE.—Mr. G. Stead, Clare College, has been appointed University lecturer in physics as applied to medical radiology. Dr. A. J. Copeland, Pembroke College, has been appointed assistant to the Downing professor of medicine. The Gordon Wigan Prize for research in chemistry has been awarded to E. H. Warren, Jesus College, for an investigation on "The Configuration of the Ammonium Ion."

It is of interest to note that of the eight successful candidates from the University in the last open competition for the Indian Civil Service, the top six studied mathematics or natural science in their Cambridge course.

EDINBURGH.—At the meeting of the University Court on December 15, it was decided to proceed at once with a scheme for the extension of the Department of Surgery in connexion with the grants recently received from the Rockefeller Foundation for the development of clinical teaching and research.

Dr. A. H. Freeland Barbour has made a further donation whereby the income of the Freeland Barbour Fellowship, awarded in each alternate year to the graduate in medicine who has taken a high place in anatomy, physiology, and pathology, and is judged most capable of carrying out research in midwifery or in diseases of women, will be increased from 120*l.* to 260*l.*

Approval by His Majesty in Council of the Court's Ordinance No. 45 (Foundation of the Chair of Organisation of Industry and Commerce) was intimated. This increases the number of professorships in the University to 55.

MANCHESTER.—Dr. W. H. Wood, lecturer in anatomy and tutor to the Faculty of Medicine, has resigned in consequence of his appointment to the Derby chair of anatomy in the University of Liverpool. Mr. H. G. Jordan, lecturer in mechanical engineering in the Faculty of Technology, has also resigned. Mr. Jordan has been a member of the staff of the College of Technology for forty-two years, and associated with the Faculty of Technology since its inception in 1906.

Mr. John Orr, at present Secretary to the Kent Rural Community Council, has been appointed adviser in agricultural economics under the Ministry of Agriculture and Fisheries Advisory Scheme, with the status of senior lecturer in the Faculty of Commerce and Administration and in the Department of Economics.

DR. W. R. COODE ADAMS has been appointed an assistant lecturer and demonstrator to Faraday House Electrical Engineering College.

DR. J. REILLY, Assistant State Chemist to the Irish Free State, has been appointed professor of chemistry in University College, Cork (National University of Ireland), in succession to Prof. A. E. Dixon.

PROF. GERLACH of Frankfort has been invited to occupy the chair of physics at the University of Tübingen in succession to Prof. F. Paschen, who was recently appointed president of the Physikalisch Technische Reichsanstalt in Berlin.

THE chairs of mathematics and English in the University of Tasmania, Hobart, will be vacated at the end of 1925. Applications are invited for them. Particulars of the posts may be obtained from the Agent-General for Tasmania, Australia House, Strand, W.C.2. The completed forms of application must be received by the Agent-General by January 31 at latest.

A DESCRIPTIVE list of "Government publications useful to teachers" as source books has been published by the United States Bureau of Education as Bulletin, 1924, No. 23. Its object is to meet a growing demand among teachers for primary sources of information to supplement text-books. The demand is especially urgent where the "project" method of instruction has been adopted. The list (34 pages, price 10 cents) is a handy guide to the publications of general interest of the United States Government—"the greatest of modern publishers."

A PRELIMINARY programme has been issued of the thirteenth annual Conference of Educational Associations to be held at University College, Gower Street, London, W.C.1, on January 1-8, under the presidency of Prof. E. A. Gardner, vice-chancellor of the University of London. The presidential address, on "Examinations: their Use and Abuse," will be delivered on the first day of the conference. Among the lectures which have been arranged are the following: "The Biology of some Common Animals," by Mr. Julian S. Huxley, on January 2; "The Measurement of Stellar Distances," by the Astronomer-Royal, on January 3; "Geography and the League of Nations," by Prof. H. J. Fleure, on January 8; "The Evidence for the Existence of Environmental Influence on the Course of Heredity," by Prof. E. W. MacBride, on January 8. Railway vouchers for return tickets for the meeting for single fare and a third can be obtained from the secretaries of the affiliated associations. A publishers' exhibition will be open in the Memorial Hall on January 2-7. The honorary organising secretary and treasurer for the conference is Miss Busk, 14 Taviton Street, W.C.1.

Early Science at the Royal Society.

December 28, 1664. Dr. Pell, upon occasion given by Sir Robert Moray, mentioned that he had at his country-house in Essex a wooden hoop, made by his directions in the year 1645, of twenty inches broad, representing the ecliptic, and at Amsterdam by Mr. Bleau lined with as much of the paper of Mr. Bleau's largest globes, as comprehends all the fixed stars within 10 deg. of the ecliptic on either side, but with the constellations inverted, as they stand in the heavens; the use of this being not only to help young observators, but also for the genuine representation of the variety appearing in the motion of the planets. He mentioned that he was willing to leave it with the Society when they shall have a fit repository to keep such instruments in.

December 29, 1686. Mr. Hooke read a further continuation of his discourse about shells, wherein he considered the structure of the nautilus, tending to prove, that though it be true, that there is no animal known resembling in all points the lineaments of those lately produced by himself; yet that it is not a sufficient argument to evince, that there is not for ever any such animal *in rerum naturâ*.

December 30, 1663. It being moved that it might be considered to make a standard of cold, it was suggested by Mr. Rooke, that this might conveniently be done by observing the degree of cold, which freezes distilled water, and by marking thereupon the expansion of the liquor in the weather-glass.—The difference of eels being discoursed of, and Mr. Henshaw mentioning the experience which the keeper of the eel-boat upon the Thames had of this sort of fish, he was desired to make what inquiry he could of that person concerning their difference, food, etc. The operator was ordered to provide some eels, and to put them into several waters, as river water, conduit water, etc., to see in which of them they will thrive best.—The business of propagating cider-fruit being again spoken of, the lord Ashley commended the red-streak, and especially the red red-streak for yielding a very rich liquor of a long duration, and for being a constant bearer. Mr. Boyle moved that some of the red-streak cider might be distilled and the spirit of it compared with wine. The lord Ashley offered a bottle for the trial.

1675. There was read a letter to Mr. Oldenburg from Mr. Newton, in answer to what had been written to him by Mr. Oldenburg concerning the want of success of his experiment made with a glass rubbed.

December 31, 1668. Dr. Wren produced a vessel contrived by himself to cure smoaking chimneys, which he affirmed had proved very effectual by divers trials. It was delivered to Mr. Hooke.

January 2, 1666/7. Mr. Hooke brought in the formerly proposed bucket for fetching up earth or any other solid body from the bottom of the sea. It was ordered, that care should be taken so to fit it, that the springs might go off both together, and that easily and certainly, and when it meets with soft ground, as well as hard; as also to grate it over.

1667/8. Mr. Panton appearing before the council, and expressing his desire for their assistance in promoting his design to establish a royal academy for educating of young gentlemen in good manners, languages, arts and sciences, and generous exercises; the council upon deliberation returned this answer, that though they well approved of this design, and were very desirous to promote it, each for himself, yet as they were a body, it was not their practice to intermeddle with any business, but such as either arose from among themselves, or came to them by way of reference.

Societies and Academies.

LONDON.

Aristotelian Society, December 1.—J. A. **Smith**: Prof. Alexander's notion of "space-time." The notion of space-time is equated by Alexander with that of pure motion. The elucidation of motion is a prime requisite for science. Alexander's aim is to help us to apprehend it immediately. Our difficulty in doing so is because we are sensitive and not purely intuitive beings. To remedy this we must endeavour to remount the stream of experience to its sources and reach a state of pure intuition. Pure motion is the simple intuition we then attain. We apprehend it not by definition but by a refinement of sensible motions and of mathematical motion. It is for science the surest and best hypothesis capable more than any other offered basis of supporting its structures.

Linnean Society, December 4.—A. B. **Rendle**: *Rafflesia Arnoldi* R. Br. and *Brugmansia Lowii* Becc., specimens sent for the British Museum by Mr. Edward Jacobson of Fort de Kock, Sumatra. They came from a forest at 800-1200 metres, near the west coast of Sumatra. Both plants are parasitic on the roots of a vine (a species of Cissus), and, except for slender threads permeating the tissue of the host, consist merely of a large flower, which in the Rafflesia measured 18 in. across.—L. J. **Wills**: The morphology of the Carboniferous scorpion, Eobuthus Fritsch. The specimen described was found near Chirk, N. Wales. It agrees fairly closely with Mr. R. I. Pocock's description of *Eobuthus holti*. The chief interest lies in the detailed structure of the chitinous test, which has been largely extracted from the shale in which it lay. The microscopic structure of the pecten can be closely matched in recent scorpions, even to the sensory papillæ. No stigmata occur on the sternites, but a thin hairy skin lies above the lobes, which no doubt protected the respiratory apparatus.—Miss V. **Hay**: Young and adult stages of *Sophora tetraptera*. Juvenile leaf-forms persist during several years on the seedlings of *Sophora tetraptera* and var. *microphylla*, and var. *prostrata*. Thus there appears to be one species with three varieties, or there may be three closely related species existing side by side under identical conditions.—Miss Violet M. **Grubb**: The development and liberation of spermatia in some undescribed cases among the Red Algæ. In *Nitophyllum Hilliæ* Grev., each antheridium mother-cell puts up in succession three beak-like protuberances, enclosed in the gelatinous extended mother cell-wall. The contents escape when ripe through an apical slit as a single spermatium clothed in a delicate wall. A similar development is found in *Callithamnion brachiatum* Bornem., where the antheridia are borne in clusters on the terminal pinnæ; secondary and tertiary antheridia grow up within the empty sheaths of the primary ones.

Royal Meteorological Society, December 17.—C. E. P. **Brooks**: The problem of mild polar climates. If there were an ice-free polar ocean just warm enough to prevent freezing at the pole and with a temperature increasing southwards at a uniform rate, and if a small decrease of temperature occurred uniformly over this ocean, a small polar ice-cap would form. If the temperature continued to fall, the growth of the ice-cap would become more and more rapid, until a point was reached beyond which the ice-cap would continue to grow without any further fall of temperature. This "critical temperature" is only about $0°{\cdot}25a$ below the freezing-point; a fall of temperature

of $0°{\cdot}25a$ would give an ice-cap with a radius of one degree of latitude, a fall of $0°{\cdot}3a$ would give an ice-cap with a radius of about 25 degrees of latitude. The "akryogenous" temperature, which the present Arctic Ocean would take up in winter if sea-water did not freeze, is about $270°a$. Hence a rise of the akryogenous winter temperature by only four or five degrees would suffice to cause a mild climate in winter. The land and sea distribution during Middle Eocene and Upper Jurassic times would give akryogenous January temperatures in latitude 75° N. of $278°{\cdot}6a$ and $280°{\cdot}8a$ respectively. Since these are well above the freezing-point they represent also the real temperatures. There is therefore a meteorological basis for mild polar climates. The Arctic Ocean has become ice-free once, possibly twice, since the Quaternary Ice Age, the second occasion falling in historic times.—Sir Napier **Shaw**: Winds and temperature in a dry atmosphere. The convection of dry air upward and downward and the distribution of temperature and potential temperature contingent thereupon would give rise to a much warmer stratosphere than the earth possesses with its present moist atmosphere. The general circulation, however, would not be different in its general character from that which prevails at present.

EDINBURGH.

Royal Society, December 8.—D. A. **Fairweather**: The electrolysis of salts of alkyloxyacids. An attempt was made to ascend the series of dibasic hydroxyacids (*i.e.* tartronic, tartaric, mucic, etc.) by electrolysis of the potassium ethyl salts of their ethylated derivatives. The products of electrolysis were of quite a different nature from those obtained in the case of the normal dibasic acids, and consisted chiefly of aldehydes; little or no synthesis took place.—W. **West** and E. B. **Ludlam**: The ionisation of iodine vapour by ultra-violet light. Iodine vapour was found to be ionised by light in the Schumann region. Quantum relations indicate that the molecule, or the fluorescing molecule, or both, may be ionised.—W. O. **Kermack** and W. T. H. **Williamson**: The stability of suspensions. I. The rate of precipitation of kaolin suspensions by salts at varying hydrogen ion concentrations. Anomalous effects in the rates of sedimentation of kaolin suspensions are observed in the cases of sodium chloride, mono-calcium phosphate, and aluminium, ferric, and lanthanum chlorides.—W. O. **Kermack** and C. I. B. **Voge**: The action of salts with multivalent cations on colloidal solutions of gold and gum benzoin. The action of solutions of ferric chloride, aluminium chloride, or lanthanum chloride in changing the charge on negatively charged colloidal particles to a positive one has been investigated more particularly in relation to the hydrogen ion concentration of the solution. The effect appears to be related to the degree of hydrolysis of the salt.—P. **MacCallum** and W. O. **Kermack**: The influence of gelatin on the stability of a colloidal solution of cholesterol and on the charge on the particles. Investigations are described on the action of solutions of gelatin at varying hydrogen ion concentrations in altering the properties of a cholesterol solution and the charge on the particles.

DUBLIN.

Royal Dublin Society, November 25.—Miss S. D. **King**: Oogenesis in *Lithobius forficatus*. Yolk formation is from nucleolar extrusion, supplemented possibly by activity of the Golgi bodies. The mitochondria are at first diffuse, later becoming concentrated. After active multiplication, which produces curious spherical mitochondrial masses, they once more become scattered through the cytoplasm. The juxta-nuclear Golgi apparatus of the young oocyte breaks up and passes out through the cytoplasm as growth proceeds.

Royal Irish Academy, December 15.—J. J. **Drumm**, N. **O'Reilly**, and H. **Ryan**: The isomeric $\alpha\alpha$ and $\alpha\gamma$ compounds of 2 : 4 : 6 : 3′ : 4′-pentamethony diphenyl propane. A synthesis of each of the above compounds is described. 2 : 4 : 6 : 3′ : 4′-Pentamethony-$\alpha\gamma$-diphenyl propane has been found to consist of colourless needles melting at 87-88° C., and to be identical with v. Kostanecki and Lampe's methylated reduction product of catechin tetramethyl ether. The above work, therefore, is in agreement with that of K. Freudenberg.

MANCHESTER.

Literary and Philosophical Society, December 16.—W. W. Haldane **Gee**: Joule's laws of electric heating. Considerable assistance was obtained in describing the early researches by the records contained in two Laboratory Notebooks in which Joule has noted his experiments. The first record relating to electric heating is dated "later end of August 1840." By October 3 in the same year Joule had completed a series of tests which enabled him to state that the heat produced by an electric current in a wire is directly proportional to its resistance, the square of the current strength and the time of its flow. He next proceeded to show that these laws applied to electrolytes. An important result of the thermo-chemical and electro-chemical determinations was a wide generalisation connecting chemical and electrical energies. A fact of historical interest in connexion with his laborious measurements was the early adoption of a unit of current strength and a unit of electrical resistance. Joule utilised his laws in an electrical method for finding specific heats. Details of his determinations are to be found in the later of the two Laboratory Books. This volume has also many records of the more accurate experiments relating to the laws of electric heating, which he submitted in a paper to the French Academy of Sciences. His calorimetric measurements were carried out to a still higher degree of perfection when in 1867 Joule showed that the value of the British Association ohm was not in agreement with his determination of the mechanical equivalent of heat. Amongst the practical outcomes of the experiments on electric heating is the process of electric welding, which Joule described in a paper in 1856 to the Manchester Literary and Philosophical Society.—J. Wilfrid **Jackson**: The occurrence of Conularia in the Carboniferous limestone of North Wales. *Conularia tenuis* was discovered in the basal beds of the Lower Brown Limestone near Dyserth. Hitherto the species has only been recorded from the Calciferous Sandstone Series at Glencartholm and Water of Leith, Edinburgh. The Dyserth Beds have been correlated with the top of the Seminula-Zone of the S.W. Province, but may be lower. They contain *Archæosigillaria vanuxemi*, which has been found in the Calciferous Sandstone Series in Scotland and at the base of the Viséan in Westmorland. The Calciferous Sandstone Series was correlated by the late Dr. R. Kidston with the Mountain Limestone of England, the overlying Carboniferous Limestone Series of Scotland being regarded as equivalent to the Yoredales of England. Dr. Kidston correlated a much higher plant-bearing horizon in N. Wales with the Calciferous Sandstone Series, namely, the Teilia Beds at the base of the Black Limestone and at least 1500 feet above the Dyserth Beds.

SHEFFIELD.

Society of Glass Technology, November 19.—Francis **Buckley**: Note on the glass-houses of the Leeds district in the seventeenth, eighteenth, and early nineteenth centuries. John Houghton, writing in 1691, stated that there were then three glass-houses in Yorkshire, one near Ferrybridge and two near Silkstone. The only glass-house actually in or near the town of Leeds in the eighteenth century was known as the Engine Glass-house, which can be traced between 1738 and 1770. The Engine Glass-house might have been the parent as well as the predecessor of the famous Hunslet Glass Works. Between 1814 and 1861, at any rate, the Bower family had several factories here. Leeds must have owed as much to this family in the nineteenth century as it did to the Fennys in the previous century. In 1883 they had four glass-houses at work, and no competition in the town itself. Just before 1850, however, there was a sudden increase in the glass concerns in Leeds and the surrounding district, especially in the neighbourhood of Castleford. An early nineteenth century glass-house at Thornhill Lees can be traced back to 1830. Here Noah Turner made flint glass until the glass-house was taken over by the Kilners in 1844, and converted into a bottle works. There was a glass-house also at Worsborough Dale prior to 1830, worked by William Usherwood, and in the year 1828 Messrs. Wood and Perkes were found in possession, making cut glass.—W. E. S. **Turner**: A striking instance of fireclay corrosion through the action of saltcake. During the emptying of a glass tank, with the gas flame still running, the fireclay blocks surrounding the dog-hole in a bottle-glass furnace began to swell and to flow soon after they became exposed to the action of the flame. When the tank was started, a charge of saltcake had probably been put into the dog-hole, under the belief that the blocking of the hole would be prevented. After examination it was found that the exposed portion of the blocks had absorbed saltcake at an early stage in the operation of the furnace, and being covered with glass and the dissociation temperature very high, the saltcake had remained unattacked, until contact with the flame during the emptying of the tank brought about decomposition.—H. S. **Houldsworth**: A note on some properties of a sandstone block after use in a glass furnace. Powdered Penshaw stone interacts as readily with a soda-lime glass as does crushed fireclay brick. Penshaw stone develops a close compact structure when used in a glass furnace. This tends to hinder the penetration of glass into the stone, thus adding to the life of the refractory, and pointing to its successful use in furnace construction.—A. **Cousen** and W. E. S. **Turner**: The production of colourless glass in tank furnaces, with special reference to the use of selenium. Pt. IV. The influence of arsenious oxide. Arsenious oxide alone is a decoloriser of glass containing small amounts of iron oxide, whilst it also suppresses the brown colour developed by selenium. Selenium and cobalt may therefore be regarded as only secondary materials in the decolorising process. An attempt to replace arsenic by its equivalent of phosphorus in the form of calcium phosphate showed the latter substance to have little or no effect upon the brown selenium colour. Antimonious oxide used instead of arsenious oxide with selenium gave a deep bluish-green colour.

PARIS.

Academy of Sciences, November 17.—M. Guillaume Bigourdan in the chair.—The president announced the death of Sir Archibald Geikie, foreign associate, and Eugène Simon, correspondant for the Section of Anatomy and Zoology.—H. **Deslandres**: A property common to spectra of different origin and structure. Preponderating action of the helium nucleus.—Maurice **Hamy**: The evolution of stars and the solar diameter.—J. B. **Senderens**: General method for the preparation of ethers. Starting with propyl, butyl, isobutyl, isoamyl, and isopropyl alcohols, the proportions of sulphuric acid and alcohol have been worked out which give maximum yields of the corresponding ethers.—D. **Mordouhay-Boltovskoy**: The transcendence of c^e and of certain other numbers.—Jules **Drach**: The problem of Tchebychew and the deformation of surfaces.—René **Garnier**: Study of the general integral of a differential system of order $2n$ round its transcendental singularities.—Paul **Lévy**: A problem of the calculus of variations.—Ragnard **Frisch**: A problem in the calculus of probabilities (the problem of Simmons).—E. **Brylinski**: The carrying away of the ether and the aberration of stars. The question as to whether the ether in the neighbourhood of the earth is or is not carried along with the earth cannot be decided by observations on the aberration of stars.—F. **Guéry**: The electric current considered as a circulation of equal charges of opposite signs. The theory of Weber is the only one at the present time in agreement with Maxwell's theory and with the hypothesis of the current being due to charges in movement in conductors.—Louis **de Broglie**: The dynamics of the light quantum and interferences.—Alb. **Colson**: The conditions of maximum solubility; the case of gypsum.—J. **Heyrovsky**: Electrolysis with the mercury drop cathode.—René **Audubert**: The photoelectric properties of the silver haloids and the mechanism of the formation of the latent image in photography.—P. **Freundler** and Mlle. Y. **Laurent**: The photochemical properties of stannous iodide.—Jean **Thibaud**: The γ-radiation of very great energy in active substances of the thorium group.—P. **Billon**: The primary β-amino-alcohols corresponding with the general formula $R.(NH_2).CH.CR_1R_2(CH_2.OH)$. The oxime of ethyl diethylacetoacetate was reduced by sodium and alcohol to the amino-alcohol, $CH_3.CH(NH_2).C(C_2H_5)_2.CH_2.OH$. The method would appear to be general.—J. **Orcel**: The determination of temperatures at which water is separated from silicates. The silicate is heated in an evacuated quartz tube by an electric furnace, and the pressure variations plotted as a function of the temperature. An example is given of the curve obtained with a sample of ripidolite (Madagascar), showing a sudden evolution of water vapour at 500°-510° C.—P. **Lebeau** and M. **Picon**: The transformation of the diamond at a high temperature *in vacuo*. In a vacuum a diamond may be exposed to a temperature of 1000° C. for twenty-four hours without change. At higher temperatures a partial change into graphite is observed. After thirty minutes' exposure to 2000° C., 10 per cent. still remained unchanged.—Jean **Jung**: The silicate enclosures of the cipolin of Saint-Philippe (Vosges, Alsace).—Jacques **de Lapparent**: The nature of the globigerina deposits in the layers between the Cretaceous and Eocene in the western Pyrenees.—Léon **Moret**: New observations on the exotic massifs of Sulens and Les Annes (Haute-Savoie).—E. **Huguenard**, A. **Magnan**, and A. **Plantol**: The variation of wind velocity with altitude near the ground.—E. **Rothé** and C. **Bois**: The earthquakes of July 10 and November 19, 1923, in the Pyrenees.—V. **Lubimenko**: The quantity of chlorophyll in the marine algæ.—L. **Plantefol**: The ecological problem for *Hypnum triquetrum*.—Armand **Dehorne**: Observa-

tion on the cells containing refractive bodies of Enchytræus (Oligochætæ). Resemblances to myelinic formations.—L. **Bounoure**: Origin of the primary gonocytes in the Triton and the signification of these elements in amphibians in general.—Denis **Bach**: The toxicity and food value of ammonium acetate for the lower fungi.— — **Pezard, Sand,** and **Caridroit**: Experimental bipartite gynandromorphism in the domestic cock. Racial recurrences governed by the autumnal moulting and the transitory character of certain pigmentary modifications.—Marc **Treillard**: The raising of *Daphnia magna* in a pure culture.—Robert **Lévy**: The mechanism of hæmolysis by scorpion poison. Comparison with other venoms.—Lucien **Cavel**: Contribution to the study of activated sludge. Very small quantities of free acid in sewage prevent nitrification and render inert the purifying properties of activated sludge.—G. **Leven**: Respiratory mechanism and treatment of serious symptoms of aerophagy.—G. **Sanarelli**: "Internal" anthrax in animals becoming carriers of anthrax spores.

SYDNEY

Linnean Society of New South Wales, October 29.—R. **Greig-Smith**: (1) The influence of certain colloids upon fermentation. Part i. Mineral colloids such as kieselguhr, kaolin, fuller's earth, silica, asbestos, as well as charcoal and agar-agar, acted as accelerating agents in hastening the fermentation of the slowly fermenting sugar, lactose, by the high temperature organism of fermenting tan-bark. Gelatinous ferric hydrate accelerated, while gelatinous aluminium hydrate retarded, the fermentation. As these are electro-positive and most other colloids are electro-negative, the electric charge had no influence under the conditions. Gelatine has no influence upon the fermentation of lactose or of itself. The precipitated phosphates of iron and alumina acted as accelerating colloids. (2) Note upon determining the hydrogen-ion concentration colorimetrically in small quantities of fluids. By using well-buffered solutions in fermentation experiments, small droplets (0·01 c.c.) may be abstracted and mixed with 0·5 c.c. of water held in the depression of a porcelain plate. On the addition of a drop of a suitable dye the active acidity can be determined, either by comparison with a drop of fluid of standardised hydrogen-ion concentration added to water in a neighbouring depression or by means of a series of coloured papers. With poorly buffered solutions dilution becomes impossible, but the plate with 0·5 c.c. of solution gives a fairly accurate picture of the acidity. Portions of agar slopes may be soaked in the 0·5 c.c. of water which soon becomes charged with the active ions and the colorimetric test can be made.—H. J. **Carter**: Australian Coleoptera. Notes and new species. No. iv. Two genera and 28 species are described as new.—G. H. **Hardy**: Australian Nemestrinidæ (Diptera). One species is described as new.

Royal Society of New South Wales, November 5.—R. H. **Cambage**: Landslides near Picton and notes on the local vegetation. The porous overlying sandstones in the locality become saturated after heavy rains and slip over the shales upon which they rest. The sandstone is calcareous, and certain trees, including the Kurrajong (*Brachychiton populneus*), seem to seek out portions of this particular sandstone formation largely because of the lime it contains. The Kurrajong avoids the more siliceous Hawkesbury Sandstone with lower lime content in the surrounding districts.

Official Publications Received.

Sixty-second Annual Report of the Government Cinchona Plantations and Factory in Bengal for the Year 1924. Pp. 9+xiv. (Calcutta: Bengal Secretariat Book Depot.) 7 annas.

Journal of the College of Agriculture, Hokkaido Imperial University, Sapporo, Japan. Vol. 15, Part 1: On a Japanese Salamander, in Lake Kuttarush, which propagates like the Axolotl. By Madoka Sasaki. Pp. 36+3 plates. (Sapporo.)

Department of Agriculture, Nairobi, Kenya Colony. Agricultural Census of the Colony and Protectorate of Kenya for 1924. Fifth Annual Report, November 1924. Pp. 28. (Nairobi.)

Canada. Department of Mines: Mines Branch. Bentonite. By Hugh S. Spence. Pp. 36+13 plates. (Ottawa: F. A. Acland.)

Department of Agriculture: Tanganyika Territory. Report for the Fifteen Months ending March 31st, 1924. Pp. 36. (Dar-es-Salaam.) 2s. 6d.

University of Illinois Engineering Experiment Station. Bulletin No. 144: Power Studies in Illinois Coal Mining. By Prof. Arthur J. Hoskin and Prof. Thomas Fraser. Pp. 82. (Urbana.) Gratis.

Diary of Societies.

SATURDAY, DECEMBER 27.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—F. Balfour Browne: Concerning the Habits of Insects (I.). Insect Collecting and what it leads to.

MONDAY, DECEMBER 29.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 3.30.—Major R. E. Cheesman: Wild Life of the Arabian Desert (Christmas Lectures for Young People).

ROYAL DUBLIN SOCIETY, at 4.—Lecture adapted to a Juvenile Auditory.

TUESDAY, DECEMBER 30.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—F. Balfour Browne: Concerning the Habits of Insects (II.). The Habits of Bees and Wasps.

INSTITUTION OF AUTOMOBILE ENGINEERS (Coventry Section, Graduates Meeting) (at Broadgate Café, Coventry).

WEDNESDAY, DECEMBER 31.

ROYAL DUBLIN SOCIETY, at 4.—Lecture adapted to a Juvenile Auditory.

THURSDAY, JANUARY 1.

GEOGRAPHICAL ASSOCIATION (Annual Meeting) (at London School of Economics), at 10.30 A.M.—Capt. M. W. Hilton Simpson and J. A. Haeseler: Life among the Ancient Hill Tribes of Algeria.—R. U. Sayce: Some Aspects of the Human Geography of Natal.—L. H. Dudley Buxton: The Historical Geography of Peking.—Miss K. de la Mare: Travels in the Western Mediterranean Region.—At 8.15 P.M.—Prof. J. L. Myres: Wayside Geography.—Prof. J. L. Myres and others: Discussion on Departmental Research Programmes.

CONFERENCE OF EDUCATIONAL ASSOCIATIONS (at University College), at 2.30.—Prof. E. A. Gardner: Examinations: their Use and Abuse.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—F. Balfour Browne: Concerning the Habits of Insects (III.). The Habits of Caterpillars.

FRIDAY, JANUARY 2.

GEOGRAPHICAL ASSOCIATION (Annual Meeting) (at London School of Economics), at 10.30 A.M.—Prof. J. L. Myres: A Geographical View of the Historical Method in Ethnology (Presidential Address).—R. Aitken: Geography and Spanish Problems.—Dr. A. Sommerfelt, H. Balfour, C. E. P. Brooks, C. B. Fawcett: A Symposium on the Life of the Fiord Peoples.

ASSOCIATION OF ASSISTANT MISTRESSES (at University College), at 2.30.—Dr. H. Crichton Miller: The Adult's Motive in Education.

SCHOOL NATURE STUDY UNION (at University College), at 3.—J. S. Huxley: The Biology of some Common Animals.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 3.30.—Dr. H. R. Mill: Some Explorers I knew (Christmas Lectures for Young People).

ROYAL DUBLIN SOCIETY, at 4.—Lecture adapted to a Juvenile Auditory.

BRITISH ASSOCIATION FOR PHYSICAL TRAINING (at University College), at 6.30.—Dr. H. Crichton Miller: Hygiene for Adolescents.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group), at 7.—J. McKissach: Some Pictorial Motives.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—W. Ringrose: Modern Flour-milling Machinery.

SATURDAY, JANUARY 3.

GEOGRAPHICAL ASSOCIATION (Annual Meeting) (at London School of Economics), at 9.30 A.M.—S. W. Rider and Capt. T. K. M. Booth: Discussion on School Geography.—Miss A. Hicks and others: Discussion on The Beginnings of Geography.—J. A. Mortlock, Miss J. A. Hardy, and others: Discussion on The Teaching of Climate.—Miss L. C. Read, C. C. Carter, and others: Discussion on Home Geography.—Mr. Cattell-Jones, Rev. J. I. Mille., and others: Discussion on School Geography Clubs and Journeys.

ASSOCIATION OF WOMEN SCIENCE TEACHERS (at University College), at 2.30.—Sir Frank Dyson: The Measurement of Stellar Distances.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—F. Balfour Browne: Concerning the Habits of Insects (IV.). The Habits of the Dragonfly.

GILBERT WHITE FELLOWSHIP (at 6 Queen Square, W.C.), at 8.—D. W. Martin: Gilbert White as Antiquary.