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Universities as Centres of Chemical Research.

THE advancement of natural knowledge is the major, if not the exclusive, aim of all purely scientific societies, and to this aim they adhere as a rule very strictly. In recent times, however, events have happened which have led to a wider view being taken of the functions of science, and hence we discern an increasing tendency for presidential addresses to wander from the narrower paths of esoteric learning and to linger awhile in the more spacious avenues that lead not only to increased knowledge, but also to improved social welfare. Progress is determined by the interplay of many factors, intellectual as well as moral and physical, and leaders in the pursuit of new knowledge can do much towards its realisation if they possess their share of the tribal conscience and have the necessary courage to speak out.

Of the many problems that touch both science and social welfare, that of research is one of the most fundamental, and in selecting this topic for his presidential address to the Chemical Society, as well as for his skill in handling it, Prof. W. P. Wynne deserves our thanks and congratulations. In this address[1] he reconsiders in the light of recent happenings the observations and conclusions expressed by Prof. R. Meldola when he spoke from the chair in 1907. In the opinion of the latter the output of research work was not "representative of the productive capacity of the nation," and the "enormous submergence of research talent" then existing was due mainly to the few openings offered by industry, the low salaries paid to junior university teachers, and to poverty compelling promising students to leave the university immediately after graduation. The one bright spot in the somewhat dismal scene was the existence of scholarship schemes associated with the Royal Commissioners of the Exhibition of 1851, the Salters' Company and the Carnegie Trust, through which men of approved ability were enabled to carry on original work after finishing their college training.

Prof. Wynne's diagnosis of the present situation agrees in the main with that of his predecessor: both indicate that lack of sufficient funds is responsible for most of our present-day defects and deficiencies. In two tables Prof. Wynne presents statistics relating to the output and distribution of chemical research in the British Isles during the three sexennial periods 1901–6, 1908–13, and 1919–24. The original chemical memoirs published in the leading chemical journals and in the Proceedings of the Royal Society, and emanating from higher educational institutions, numbered 865, 1271, and 1464 in the respective periods.

[1] Journal of the Chemical Society, vol. 127, April.

To these totals the Universities of Oxford, Cambridge, and Manchester, together with the Imperial College (Royal College of Science and C.T.C.), contributed, collectively, 33·8, 36·5, and 34·8 per cent., the London colleges, modern English universities, and Welsh, Scottish and Irish universities, 57·8, 53·2, and 56·1 per cent., whilst the technical colleges accounted for only 8·4, 10·3, and 9·1 per cent. The persistent comparative sterility of the technical institutions is ascribed to the unenlightened outlook of the governing bodies concerned; and the approximate uniformity in the number of contributions from each of the three groups is regarded as accidental.

Interesting as the detailed figures given in the printed address undoubtedly are, their significance must not be overestimated. In the first place, it may be doubted whether numbers of papers published can afford an unambiguous index of research activity. The criticism is often heard that modern workers are far too prone to publish small instalments (scraps !) of work at frequent intervals, rather than to wait until their investigations have attained a reasonable degree of completeness. Publication of original research has become an almost indispensable condition of promotion in the academic sphere, and hence the young worker seeking notoriety and quick promotion may publish half-a-dozen small contributions in the same interval of time when a classical worker of the old school might have published only one. Secondly, the statistical method used by Prof. Wynne takes no cognizance of quality, and quantity without quality is of no greater moment in science than in art or morals. Whilst, therefore, we may agree that Prof. Wynne's figures warrant the conclusion that there has been a steady increase in the volume of chemical research—though not to the extent implied by the figures—there is nothing to indicate that there has been any corresponding increase in value. The statistical method very often breaks down when applied to things of the spirit.

In not repeating or endorsing his predecessor's opinion concerning the output of work being incommensurate with the productive capacity, Prof. Wynne takes a wise course, because the question of productive capacity in the intellectual sphere must be very largely a matter of conjecture, and unless we have some fairly accurate means of measuring, it must be wrong to predicate any quantitative relationship between output and capacity to produce. The belief may, however, be justified that, following the extension of educational facilities in our secondary schools, due to the enactment of the Fisher proposals, capacity for research is being increasingly developed, or rather, that those gifted with it are not being overlooked to the same extent as formerly. Unfortunately, secondary education shares with university education the same handicap of lacking adequate financial resources, and therefore until better times arrive, both have to cut their coat strictly according to their cloth, compromise, and postpone enterprises of great pith and moment.

Prof. Wynne recalls that the university colleges passed their early lives in poverty, so that their administrators came to judge the success and the needs of departments by the number of students working in them, and to regard all departments as of equal value and importance; and these views still persist. The relatively high cost of maintaining laboratories remains an added handicap to scientific departments, and it is suggested that in allocating grants, more consideration should be given to the number of post-graduates engaged in research, and to the number of hours actually spent in teaching. Science demonstrators and assistants have to spend long hours in the laboratory, and therefore they should be given more free time for their own work. Since, however, the universal call for economy rules out any increases in staff, it is of fundamental importance to inquire whether greater efficiency could not be secured by abandoning the present policy of allowing each university to attempt to excel in many branches of pure and applied science, and by substituting therefor more localisation and greater concentration of effort.

For the old-established scholarship schemes for post-graduate research work Prof. Wynne has nothing but praise; the figures he gives show that far more scholarships are awarded for chemistry than for any other science. The Beit Memorial Fellowship and the Ramsay Memorial Fellowship Trusts have increased considerably the sums available for this work, whilst the Department of Scientific and Industrial Research, by giving maintenance grants for training in research methods, "has done a service to science and the country so great as to be almost incredible in the light of pre-War neglect." Its annual expenditure since 1920 in grants for research training in branches having industrial applications has been between 40,000*l.* and 50,000*l.*

The institution of the Ph.D. degree for research work was a war-time measure, originating in the desire to attract to our universities students from the Overseas Dominions and foreign countries who formerly would have studied in Germany. It was recognised at the outset that success of the scheme for such a degree would depend mainly upon the expenditure of large public funds to improve the equipment of our laboratories and to provide increased amenities for the students; such expenditure has, unfortunately, not been found possible. A serious blemish in the regulations for this degree is the non-provision of travelling scholarships for home students, as the

value to them of change of environment is very great. Since there is no immediate prospect that this defect will be remedied, Prof. Wynne suggests (1) that the Department of Scientific and Industrial Research should only renew its grants after the first year to students who migrate to another institution; (2) that the grants be renewable for a third year; and (3) that during the two years' absence from home the maintenance grant be increased.

Despite the acute and prolonged depression in trade, there has been a distinct change in outlook with regard to the employment of trained research chemists in industry, and for this the institution of research associations by the Department of Scientific and Industrial Research is largely responsible. Manufacturers, however, still complain of the inefficiency, from the works point of view, of the university-trained man; but, asks Prof. Wynne: Are the universities entirely to blame? What opportunities do industrial firms offer him for testing his vocation while there is yet time for him to make another choice? Is it not possible to allow selected students to spend some part of each long vacation in the works, not necessarily in the laboratory, but under foremen on the plant? The common objections relating to the violation of secrecy and interference with routine have been successfully overcome in Sheffield, where the presence of intending graduates is welcomed in the steel-works during the long vacation. There seems no valid reason why the example of Sheffield firms should not be followed in other centres and in other industries.

Finally, Prof. Wynne appeals to the Association of British Chemical Manufacturers to assist and co-operate with the universities in such matters. He recalls the fact that the Chemical Society took a leading part in launching the Association, but he did not mention, as he might have done, that the conferences of the chemical societies which led to its foundation were convened to consider the best methods, not only for promoting co-operation among chemical manufacturers, but also co-operation "between them and the teachers in universities, colleges, and technical schools." The Association has admittedly done good work for the manufacturers, and in support of Prof. Wynne we venture to express the hope that it will add to its laurels by working with and assisting institutions of higher education. As Prof. Wynne says, "University and industry—theory and practice—obviously must collaborate if the chemical industry of this country is to make headway in face of present difficulties"; indeed, without the co-operation of the universities, the industry can neither hope to prosper in times of acute international competition, nor fulfil its patriotic obligations in times of international strife.

National Art in the Stone Age.

Urgeschichte der bildenden Kunst in Europa, von den Anfängen bis um 500 vor Christi. Von Moritz Hoernes. Dritte Auflage, durchgesehen und ergänzt von Oswald Menghin. Pp. xix + 864. (Wien: Kunstverlag Anton Schroll und Co., 1925.) 30 gold marks.

ALTHOUGH written history begins in Europe two thousand years later than in Egypt or Mesopotamia, the archæological record is nowhere longer or more continuous. Art is more the object of the archæologist than the philologist; and in this domain Europe is exceptionally rich. The men of the Old Stone Age decorated bones or cave walls with marvellous drawings which recall to life an extinct fauna. But the naturalism of palæolithic art passed away with the advent of more modern climatic conditions; in France and Spain, the centres of quaternary art, only conventionalised and æsthetically worthless survivals are to be found on the walls of Copper Age cave-shelters and dolmens. Only in the extreme north did a naturalistic art, stylistically if not genetically akin to that of the cave-men, persist throughout the New Stone Age among backward food-gathering tribes. From that period, which saw the establishment of food-producing economy, no artistic products have elsewhere come down to us save geometrically decorated vases and rude clay figurines.

The same geometric character pervades continental art in the Bronze and early Iron Ages. But in the Ægean in the seventeenth century B.C., a new and deliberate naturalism arose under the shadows of the Cretan palaces, only to fall a prey to conventionalism and eventually to become geometric in the "Greek Middle Ages," as Hoernes happily describes the Late Mycenæan and Dipylon periods. The final revival of naturalism begins in the city-states of archaic Greece, and Etruria, then among the Celts of La Tène, and finally among the Teutons in the first centuries of our era. Hoernes saw in these transformations the reflection, not of racial, but of economic and social changes. The primitive naturalism was proper to the parasitic life of hunters. Geometric styles correspond to the symbiotic economy of peasants, and in the permanence of their designs betray the prominent part played by women in the new industries. A synthesis of the foregoing moments in a class-society wherein a "parasitic" layer of rulers, priests, and warriors has been superimposed upon the peasantry evokes the conscious naturalism of Middle Minoan Crete or La Tène. With these masterly generalisations the Viennese professor summed up abstractly the artistic evolution of our continent.

In presenting the evidence on which these conclusions

were based, Hoernes adopted an almost equally abstract method. Writing in 1914, he did not believe in the possibility of identifying racial groups by archæological data. In the ten years since his death, the immense progress of science has left the prehistorian no alternative but to adopt the concrete methods of the historian. His characters are indeed nameless and the individual still eludes him, for in the epoch with which he deals the individual was still merged in the collectivity. Prehistoric art is like modern peasant art; it is far more the product of the group, the embodiment of its æsthetic traditions, than the creation of an individual artist. On the other hand, just as peasant art in Brittany is distinct from that of the Ukraine, so the several styles of geometric decoration on neolithic pottery must be regarded as embodying the ideals of specific racial groups. Hoernes' pupil and successor, Prof. Menghin, is animated by this principle throughout the two hundred pages of his appendix. Thus even in the Old Stone Age the "impressionist" scenes painted on the rocks of southern Spain may be contrasted with the isolated realistic figures depicted farther north. This contrast illustrates the distinction between a race newly come from Africa (the Capsians) and more Eurasiatic stocks.

In the New Stone Age the archæological map of Europe discloses a veritable mosaic of cultural groups. The sharpness with which these nameless peoples stand out, the precision with which their migrations can often be plotted, will come as revelations to English readers. Pottery is now the best guide to their identification and the principal vehicle for their artistic self-expression. Thanks to Prof. Menghin, we now have for the first time a complete and reasoned account of the ceramic styles and their interrelations. The loess-lands of the Danube valley are occupied by peaceful peasants. Fine pottery adorned with spirals and mæanders defines the extent of their colonies; derivative types growing into local styles mark their gradual expansion to Poland, south Germany, and Belgium. From the west (probably from Spain, for brachycephals are found there despite Menghin's statement to the contrary) a short-headed race of armed traders introduce their bell-shaped beakers into central Europe, there mingle with a Nordic tribe, and eventually invade Britain. But the real plot of European prehistory is the victorious expansion of the "Nordic culture." The latter, Menghin frankly attributes to Indo-Germans (*i.e.* Indo-Europeans or Aryans); for he is a Germanist albeit a temperate exponent of theories often travestied by too ardent advocates. The submergence or absorption of the Danubian peasant art by that of Nordic invaders is in any case patent. It provides a truly historical explanation for that contrast between peripheral and tectonic styles of decoration upon which Hoernes based his whole treatment of neolithic pottery; for the metopic division of the vase-surface was as characteristic of the North as the free ornament was of the Danube valley.

Here, as in the analysis of west European cultures, the concentration on ceramic evidence imposed by the plan of Hoernes' work tends to hide difficulties. The internal incoherence of the "Nordic culture," notably the opposition between the separate-grave folk of inner Jutland and the megalith-builders on the Danish coasts, would have become more glaring had weapons and ornaments been considered. Conversely, chronological difficulties have been evaded by giving the "Caucasian pottery" the status of an independent group. It can, however, only rank among the subdivisions of Menghin's Nordic group; direct genetic relationship is demonstrated *inter alia* by the very peculiar type of tomb in which similar vases occur both on the Saale and on the Kuban (Menghin's printer has consistently confused this river with the Iron Age site of Koban). If the high antiquity of the latter tomb really precludes its attribution to a clan hailing from central Germany, the only alternative is to invert the direction of the journey.

If, however, the warlike Nordics must claim the attention of the historian, they have little to offer to the artist. On the other hand, the peaceful peasants of the south-east have left us monuments of real beauty—magnificent painted vases. The Thessalian group is already familiar; this well-illustrated account of the Transylvanian-Ukrainian vases and figurines will be all the more welcome. We would, however, suggest certain corrections. The most important site yet excavated—Erösd—is omitted. Now the inhabitants of this Copper Age village, nestling among the mountains of Transylvania—the ancient El Dorado of central Europe—not only decorated their vessels with polychrome spirals and mæanders but also adorned the walls of their substantial houses with frescoes and plaster mouldings. Then pottery virtually identical in technique and decoration with that of Erösd appears intrusively in a corner of Thessaly. How can Menghin deny that this intrusion marked an invasion from beyond the Balkans? In Thessaly this genuine painted fabric gives place to the curious "crusted" ware on which the colours are applied only after the burnishing and firing of the vase. The same technique is encountered in the Danube valley from Serbia to Moravia. But Hoernes and Menghin have not distinguished it from true painting, and so have missed the essential cultural continuity between Thessaly and the Danube valley at this period. In fact they treat the Danubian crusted ware as older than and partly the ancestor of

the painted pottery of Transylvania, whereas the stratigraphical sequence in Thessaly would suggest just the opposite relation. Finally, the curious way in which stylised animals come to figure among the geometric designs of the latest painted pottery in Galicia and the Ukraine is surely a phenomenon worthy of note in a history of art. However, the painted pottery appears with meteoric brilliance only to vanish utterly in the night. Perhaps the vase-painters were submerged by the same Nordic flood that had overwhelmed the peasants of the Danube valley.

The remaining ceramic groups distinguished by Menghin are of less artistic or historical significance. He finds no continuation for the mesolithic wares of the Danish kitchen-middens and Campigny and, with less justification, isolates the neolithic pottery of Crete from its successors and neighbours. The artistic capabilities of the rude hunters of the extreme north are better expressed in their carvings than in their coarse vases. Finally, all the wares of western Europe and north Africa are classed together in one admittedly amorphous group. Incidentally, while flattered by the prominence accorded to English neolithic wares in the last-named group, we deplore the neglect of the richer Scottish material.

As a whole, this book with its 1462 illustrations constitutes a veritable corpus of neolithic pottery; and the art of the later periods and of the Ægean is treated with no less thoroughness and lucidity. If there be room for differences of opinion on isolated points as indicated above, that is but natural in a pioneer work on a young science; no such detailed or comprehensive survey of European prehistory has ever before been attempted in any language.

V. GORDON CHILDE.

The Study of Corals.

An Introduction to the Study of Recent Corals. By Prof. Sydney J. Hickson. (Publications of the University of Manchester, Biological Series, No. 4.) Pp. xiv+257. (Manchester: At the University Press; London: Longmans, Green and Co., 1924.) 25*s.* net.

AMONG living zoologists no one is more competent than Prof. Hickson to write a book on corals. Many years ago he made acquaintance with coral organisms in their natural surroundings; and since then the Anthozoa, the group to which most corals belong, have been one of the chief objects of his study. Those, therefore, who already know his lucid and attractive manner of writing will be prepared to expect an authoritative and fascinating work; and they will not be disappointed. But first one or two small criticisms.

The author's definition of the word "coral" will probably excite surprise by its breadth. He uses it for marine sedentary organisms, animal and vegetable, "that produce a solid skeletal (or more accurately *shell*) structure of calcium carbonate which persists as such entire, after the death of the living organisms that produced it." The things included in the term corals are therefore the calcareous marine plants, certain Foraminifera and sponges, the madreporarian corals, certain Alcyonaria (such as the precious coral) and Hydrozoa, and also some genera belonging to the Polyzoa and Annelida. But has the term coral ever been used, even popularly, in such a wide sense as this? In practice Prof. Hickson widens it still further by including Gorgonia and the antipatharians, the skeleton of which is not calcareous at all. Parenthetically, would the skeleton of the precious coral ordinarily be termed a shell structure, and is it "strictly speaking, an outside support or exoskeleton" (p. 17)?

We shall not quarrel very seriously, however, with the definition proposed by the author. He has had the happy idea of describing for us, in an easy and delightful fashion, a number of organisms which have interested him, and of illustrating his descriptions by choice examples of the photographer's art. He is in want of a term under which these can be subsumed; and "coral" is at least not altogether inappropriate—is as suitable, at any rate, as any single word can be.

One other objection to the author's use of terms. We shall not all agree that "the conception of individuality has no relation to the structure or function of the parts but to the discontinuity of the living organism as a whole from other living organisms"; though it may perhaps be true that "the Alcyonium or the Tubipora as a whole is, *in common language* (italics the reviewer's), the individual, and the polyps parts or organs of the individual."

Coming to the contents of the volume, the introductory chapter, "On the Use of some Words," deals with the meaning of "coral" and "individual," which we have just alluded to, to that of "polyp" (which Prof. Hickson extends to the zooids of the Polyzoa) and "zoophyte." Chap. ii. gives a short account of structure, especially of that of an anthozoan polyp, and classification; to it is appended an interesting "Additional Note on the Nutrition of Corals," discussing the part played by symbiotic algæ. Chaps. iii. and iv. (pp. 23-102) deal with madreporarian corals; this, the backbone of the subject, is attractively treated in a simple style and in clear language, made even clearer by diagrams and by exquisite reproductions of photographs (we dare not, in this journal, imitate Prof. Hickson (p. 190) and write photos) of the actual objects. It is confusing and contradictory, however, to state,

of the mesenteric muscular bands, that "in the cases of the directive mesenteries these ridges are on the surfaces *opposed to each other* (italics the reviewer's), that is to say, they face outwards" (p. 33). The interesting association of Heterocyathus with the gephyrean Aspidosiphon is described on pp. 39-40.

Alcyonarian corals are described in Chap. v.; Corallium, Tubipora, Heliopora and Gorgonia are treated at some length, a number of other genera more cursorily. Chap. vi. disposes of the antipatharians in a few pages; and successive chapters are given to the hydrozoan corals—Millepora and the Stylasterina; polyzoan corals; foraminiferan and poriferan (Merlia) corals and annelid worm tubes; and lastly coral Algæ—the red seaweed corals and green seaweed corals.

The penultimate chapter is something of a disappointment. We feel that in a volume on corals by Prof. Hickson we had a right to expect more than 17 pages on coral reefs; we would willingly have sacrificed the worm tubes, sponges, and Foraminifera, as well as the Algæ, to have had an equivalent here. The author's very first words—the opening sentences of the preface—speak of the fascination, the charm, and the enduring interest of the life of the reefs; but he gives us little more than a brief account of the composition and form of the reefs, and of the theories of their formation.

The last chapter gives an agreeable account of the trade in black and red coral from the earliest times. Among much other interesting information we are told that some years ago a great bronze shield, supposed to belong to the Early Iron age, was found in the bed of the river Witham in Lincolnshire, bearing five large pieces of red coral, each circular in outline, ground to form a convex surface and polished; and that armour decorated in a similar way has also been found in Ireland. Even in the eighteenth century red coral was much esteemed as a drug, being given, for example, in a paste along with crabs' eyes and other things, for fevers in children.

The book is obviously intended to be of use to the intelligent layman, who has only the most elementary acquaintance with physiology and anatomy. But it will certainly be read largely by others; not only by elementary but also by advanced and honours students of zoology who are making a special study of the Anthozoa. For these, as well as for zoological amateurs, it will be a delightful occupation to go round the cases of the Manchester Museum, or of the British Museum, with Prof. Hickson's book in hand. We congratulate the author on his accomplishment; would that all zoologists, before the conclusion of their active life, would give us similar accounts of the groups which have formed the subject of their researches.

Morphology of the Alimentary Canal.

Vorlesungen über vergleichende Anatomie. Von Prof. Otto Bütschli. Lieferung 4: Ernährungsorgane. Herausgegeben von F. Blochmann and C. Hamburger. Pp. iv+380. (Berlin: Julius Springer, 1924.) 6·45 dollars.

THIS is a compilation of a kind which we expect from the patient industry and passion for orderly arrangement of the German scientific writer. It is a mine of information from which details of the structure of the alimentary canal of a very large number of animals can be extracted with a minimum of trouble. To the English zoologist it will appeal most because it is illustrated with the thoroughness which the German author rightly believes to be necessary, and the illustrations are selected with characteristic care. A large proportion of them are entirely new to text-books, and many of them are from original drawings of Bütschli. But for the fact that they are sometimes rather too small to be easily understood, they are really excellent and a substantial justification for the publication of the book.

When we consider the text, however, there arises the question as to how far a morphological encyclopædia of this kind is valuable to zoologists. It has, indeed, occurred to the authors that a certain amount of physiological information should be incorporated into their work. This is, however, relegated to paragraphs of small print for the most part and, even making allowance for the scantiness of present-day knowledge, is insufficient. The alimentary canal lends itself less to purely morphological comparisons than any other system of the body. It is so plastic that astonishing differences may exist between closely related animals which are obviously related to differences in diet. To take an example, the excellent morphological account of the alimentary canal of the Mollusca seems incomplete to the reviewer because the varied habits and physiological characters of such forms as nudibranchs, heteropods, boring lamellibranchs, and many others are never mentioned. The initiated may be able to fill up the gaps, but there is not much help for the student who wants to know how much of the form is related to function. Nor is there usually more than casual reference to the histology of the various alimentary organs. This is no doubt outside the scope of the work, but it may well be claimed that, in the study of the alimentary system, histology is as indissolubly connected with gross anatomy as physiology.

It is surprising to find that there is practically no introduction and no general summary, which is surely needed here. The fact is that treatises on comparative

morphology and comparative physiology as well (like the stupendous Winterstein) do everything but compare. They present an array of densely marshalled facts through which the reader travels despairingly, being quite unable to see the wood for the trees.

Pottery and Porcelain.

Pottery: being a Simple Account of the History of Pottery and a Description of some of the Processes employed in its Manufacture. (Pitman's Common Commodities and Industries.) By Charles J. Noke and Harold J. Plant. Pp. xi+136. (London: Sir Isaac Pitman and Sons, Ltd.) 3*s*. net.

Pottery and Porcelain: a Handbook for Collectors. Translated from the Danish of Emil Hannover. Edited with Notes and Appendices by Bernard Rackham. Vol. 1. Europe and the Near East: Earthenware and Stoneware. Pp. 589+7 plates. (25*s*. net.) Vol. 2. The Far East. Pp. 287+2 plates. (18*s*. net.) Vol. 3. European Porcelain. Pp. 571+2 plates. (25*s*. net.) (London: Ernest Benn, Ltd., 1925.)

THE first-mentioned of these works might, happily, serve as an introduction and technical aid to the important and comprehensive handbook with which it is associated in this notice. Its authors have accomplished their modest scheme with such ability and success as to give the reader who is not a potter an insight into the practical methods which are followed in the manufacture of the multifarious articles of pottery and porcelain, whether intended for everyday use or as the embodiment of precious artistry, which men treasure in our day even as they seem to have prized and collected such things for unnumbered years. The clarity and simplicity with which the technical information is presented—together with excellent illustrations and photographic reproductions of the tools, methods, and processes used by the Staffordshire potters of our time—deserve warm commendation. Apart from the immediate aim of the writers, which has been to aid the student-workman who is engaged in the craft, every collector of pottery and porcelain who wishes to acquire clear ideas of how the precious objects he treasures were made will find this a handy and reliable little work of reference, to be used in conjunction with those voluminous histories of the potters' achievements in which technical matters are not always treated with such simplicity and precision.

The scholarly and comprehensive handbook for collectors compiled by the late Dr. Emil Hannover and here translated for English readers by Mr. Bernard Rackham, one of our foremost museum authorities—who also contributes greatly to the value of this English edition by an extensive series of explanatory notes and addenda—displays at once the strength as well as the weakness of any survey, aiming at completeness, of such an extensive field by any single author. Undoubtedly, Dr. Hannover's narrative gains in unity of purpose and of outlook because all the ideas have been distilled through the alembic of a single, well-informed mind. It is, however, almost inevitable that certain sections of any work that proposes to set forth the complete history of an artistic craft that is coeval with civilisation, which must therefore comprehend all the fictile arts of the Greek, Persian, Chinese, Japanese, and European peoples—to mention only the more important—should be less satisfactory in judgment and understanding than others. Having entered this modest *caveat*, the reviewer is free to appreciate the fare so abundantly set forth for the reader's delectation and instruction.

It is only possible in the space at our disposal to direct attention to the more salient features of the work, for as a comprehensive bibliography of ceramic literature is included, the reader who requires fuller information on any specific point will readily find the most authoritative sources to which he may turn for further enlightenment. Another feature, which adds to the completeness of the work and its consequent value to collectors, especially to those who have but recently acquired that delightful hobby, is the valuable descriptive notes and illustrations of "forgeries"; for though, as Dr. Hannover says, "the really dangerous counterfeits can only be distinguished by acquiring a thorough knowledge of the genuine things," it is possible to prepare one's self for meeting the spurious thing and its recognisable defects.

It seems but natural that one should instinctively turn to the volume which deals with the ceramic productions of the Far East, especially as for the last two centuries these Oriental wares have exercised such a powerful influence on all European pottery and porcelain, with the exception of the stonewares. In the few years that have elapsed since the close of the War, all competent observers must have been impressed with the number of artist-potters, working on their own account or in association with old-established factories, in all European countries, who have turned with a fresh, often a childlike eye to the older treasures of Chinese and Japanese skill and are now exhibiting their pleasure by the production of works which, though frankly European in style, are not ashamed to acknowledge the sources of their technical inspiration.

In the same way, Dr. Hannover, having absorbed all that has been written by the foremost authorities, gives us a condensed but eminently readable account of the growth and development of the ceramic arts in

the Far East in his second volume. As to the spirit in which he entered into his work, one cannot do better than quote a short section from his summary of the position of the art in China at the end of the fourteenth century:

"For if a piece of five-coloured Ming or of K'ang Hsi blue-and-white often appeals with greater sweetness to the senses than almost any other fruit of human craft and genius, it is due to the fact that the object itself, by virtue of a continuity hardly conceivable in any but the most conservative country in the world, is the product, ripened with infinite slowness and infinite sureness, of traditions more than a thousand years old. It is to the oldest pottery, here briefly described, that we owe this tremendous acknowledgement."

The reader will turn to Vol. I., which treats of the earthenwares and stonewares of Europe and the Near East, with the assurance that the author, from his position as Director of the famous Museum of Industrial Art at Copenhagen, will have a first-hand acquaintance with the work of the European factories, particularly with those of the northern and eastern countries, of which British museums can scarcely be said to contain thoroughly representative collections. As Mr. Rackham notes in his "foreword,"

"The sections in Vols. I. and III. relating to the potteries of the Scandinavian region, although treated on a somewhat fuller scale than the remainder of the book, have been allowed to stand unshortened. No full accounts of the Northern wares have ever been published in English; much even of the author's work in this section of the book embodies entirely new research which had never before been published in any language. It seemed therefore essential that his valuable contribution to ceramic history should be given in full to the English reader."

All of which is very handsome of Mr. Rackham, especially as Dr. Hannover treats our British pottery in very summary fashion, and expresses in round terms an idea that I have often heard from keepers of Continental museums when he writes:

"for, as we have many times noted, when speaking of conditions on the Continent, it was English earthenware in the classical and insinuating form given to it especially by Wedgwood and Leeds that was the doom of the old faïence. And not of faïence only—this great English industry put an end to the development through more than two thousand years of *all* the ceramic arts, porcelain not excepted."

The volumes are profusely illustrated with half-tone plates, generally of admirable clearness, and, in addition, there are a few coloured plates of great beauty. Such plates as that of the Marieberg Tureen (Plate VII., Vol. I.) will be new to the majority of English collectors.

WILLIAM BURTON.

Ubique.

The Roll of Honour of the Institution of Electrical Engineers. Pp. xv+330+40 plates+6 maps. (London: The Institution of Electrical Engineers, 1924.)

THIS very handsome volume contains biographical notices of the 162 members of the Institution of Electrical Engineers who lost their lives in the War, 1914–1919.

The extremely able summary of the origin and causes of the War, as well as all the biographical notices, have been written by Bt.-Lieut.-Colonel W. A. J. O'Meara, C.M.G., (late) R.E., and his task, which took him no less than five years to accomplish, has been performed in a truly admirable way. All the notices give details of the particular member's life prior to the outbreak of War, followed by a comprehensive and sympathetic summary of his service in the field. Further, in all cases, every action mentioned is linked up with the actual operations that were in progress at the time, so that a true perspective is maintained and continuous interest is ensured. Nearly every notice is accompanied by a well-reproduced portrait, and in a pocket at the end are placed six excellent maps of the various theatres of War, on which the operations can be readily followed.

On analysing the services of these 162 members, it is seen that in August 1914 only five belonged to the old regular fighting Services, one each to the R.N., R.A.F., and R.A., and two to the R.E. Of the others, one cannot fail to be struck by the fact that, despite their specialised engineering education, the Royal Engineers did not claim more than 40 of them. The remainder were allowed to join almost every branch of the Service, and they are found in the Royal Navy, yeomanry, artillery, infantry, and Air Service; with trench mortars, in the Machine-Gun Corps, in the Army Ordnance Department, Army Service Corps, Friends' Ambulance Unit, on the Embarkation Staff, in the Indian Defence Force, and with the Expeditionary Forces from Canada, Australia, New Zealand, and South Africa. They performed technical duties in the Anti-Submarine Division, with searchlights, and in sound ranging. Nevertheless, in reading their biographies, it is impossible not to recognise the fact that in whatever branch these men served, their knowledge of engineering was always valuable, and they were able to make use of it in many ways, both for the assistance of their own unit and in furtherance of whatever operations were being undertaken.

To take a few instances: One member, a student of 1912, Lieut. (later A/Major) D. G. Trouton, belonged to the R.F.A. (Special Reserve) at the outbreak of War, and he was at once posted to the 2nd Divisional

Ammunition Column, and with it proceeded to France in August 1914. He served throughout the retreat from Mons and subsequent advance to the Aisne, and he was seriously wounded during the battles of Ypres 1914. Later, he served through the Suvla operations with the 11th Division, until he was invalided with dysentery in November 1915. Rejoining in France, he took part in the battles of the Somme 1916, and was again seriously wounded. Returning again to France before the close of the year's fighting, he was in the battle of the Ancre Heights. In 1917 he was engaged in the battle of Messines and then in the battles of Ypres 1917. Shortly after promotion to A/Major, he was killed in his battery position in the first battle of Passchendaele on the day before his twenty-fourth birthday. He well deserves the stirring pages devoted to his long war record and gallant services.

The spirit shown by members of the Institution on the outbreak of hostilities is well illustrated by the case of Rifleman A. T. Mahon. A student in 1913, he at once offered his services. Rejected on chest measurement, he underwent a course of physical exercises and offered himself every month until he was finally accepted in February 1915. He then joined the 5/London Regiment (London Rifle Brigade). He went to France in August, and in due course joined the signal section of his battalion. His division (56th) took part on July 1, 1916, in the ill-fated attack on Gommecourt. At the height of the fighting, his battalion being isolated and ammunition running low, the signallers were ordered to establish communication by wire with the troops. To carry out this task Mahon and a comrade, taking their instruments, at once went forward to what was almost certain death. That night Mahon was reported missing, and afterwards he was presumed to have been killed. Devotion to duty of this nature is sometimes awarded a very high distinction, but Mahon's gallantry remains its own reward. It must have given Col. O'Meara a melancholy satisfaction to save this fine deed from oblivion.

The Dominions, too, are well represented in this Roll of Honour. Lieut. (Hon. Capt.) A. T. Hayne, D.S.O., D.F.C., who was born and educated in South Africa, had come to England in 1913 to take a four years' course in electrical engineering. By the time the War broke out he had already acquired a thorough knowledge of internal combustion engines, which proved invaluable to him later on. He joined up in January 1915, and after serving in the autumn at Helles with the armoured cars, he transferred in 1916 to the R.N.A.S., and went to France in January 1917. In this theatre he performed splendid service, for he had to his own credit twenty enemy machines brought down in single combat, and in one set of operations he carried out no less than forty-eight special missions. Unfortunately, in April 1919 a machine that he was testing crashed and he was killed instantaneously.

Another overseas member, Major H. C. Symmes, was born in Canada. He took the five years' course in mechanical and electrical engineering at McGill University. Later he joined the Canadian contingent and went with it to the Boer War. After the contingent returned, Symmes remained behind in Pretoria working on the staff of the Transvaal railways, and in 1911 he became Inspector of Machinery and Electricity in the Mines Department. He at once volunteered for service on the outbreak of War, and, in command of a company of the Witwatersrand Rifles, he served in the campaign in German South-West Africa. He then proceeded to Europe with the South African Brigade, and in July 1916 he took a reinforcing draft to France. In October 1916 he participated in the heavy fighting for the Butte de Warlencourt, in which operations the South African Brigade lost 45 officers and 1150 other ranks. Major Symmes was killed on the first day of the battles of Arras 1917, whilst gallantly leading his men.

Our allies also furnish three members in this Roll of Honour. Belgium is represented by Caporal W. R. E. Claeys, and France by Sergent J. H. Labour, and l'Inspecteur-Général G. P. Seligmann-Lui, Director-General of Telegraphs and Telephones at G.Q.G., and all three have most distinguished civil and military records.

A copy of this Roll of Honour has been sent to each member's next of kin, and the Institution is indeed to be congratulated on the form of memorial it has chosen, with the idea of perpetuating the names of its members who died in the War and ensuring that their services shall live for evermore. Men who came from the ends of the earth to fight for their country, who placed patriotism before mere private profit, using their engineering skill and finally giving their lives for the cause, "the wide earth is their sepulchre."

Fatigue and other Properties of Metals.

(1) *The Fatigue of Metals.* By H. J. Gough. Pp. xx+304+14 plates. (London: Scott, Greenwood and Son, 1924.) 25*s.* net.

(2) *Grundbegriffe der mechanischen Technologie der Metalle.* Von Dr. Georg Sachs. (Die metallische Werkstoff: Gewinnung, Behandlung, Veredlung. Band 2.) Pp. x+319. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1925.) 13 gold marks.

(1) MR. H. J. GOUGH, a member of the staff in the Engineering Department of the National Physical Laboratory, has written a book on a subject to which he has himself made valuable original

contributions. This in itself gives it unusual value, for he writes with first-hand knowledge and authority. The title itself needs some explanation. The phrase "fatigue of metals" has long been used by engineers to denote phenomena leading up to the failure of metals under repeated stresses. The original underlying idea was that, under these conditions, the metal gradually became "crystalline," and that this was the primary cause of its breakdown. Modern research, however, on the crystalline structure of metals has shown that this is not the case, that no crystallisation occurs, but that the failure takes place because the metal ultimately breaks on a comparatively few planes which, on account of their size, give the appearance of crystallinity. As the author points out, the term is far from ideal, being both indefinite and rather misleading. He tells us that "our ideas of fatigue phenomena must frankly be admitted to be in the melting pot," and that "no research yet published has been sufficiently fundamental" to characterise satisfactorily this phenomenon.

In spite of this, however, Mr. Gough uses the term because it is so widely employed, but he defines it quite generally as "the behaviour of metals when subjected to repeated stresses." Examples of this are numerous, and include the axles of railway carriages and trams, crank shafts and connecting rods of reciprocating engines, hulls of steam-ships, motor-car springs and chassis, railway rails and tyres, shafts of steam turbines, teeth of pinions, valve springs, and many machine details.

The subject is of supreme importance on account of the present-day tendency to employ high working stresses and speeds in the design of machines and prime movers. Dr. Stanton, who contributes a foreword to the volume, remarks that Rankine clearly anticipated in many ways the results of research in this field, and that since the publication of Wöhler's experiments in 1860–70, investigation has proceeded in two main directions. On one hand, methods of determining the fatigue range of stress on material under given conditions have been so much expedited that the whole determination is now only a matter of an hour or two; accordingly, this has brought the fatigue test within the scope of standard tests of materials. Twenty years ago it took so long to perform that it would have been quite impossible to include it in any specification. On the other hand, attempts to try to understand fatigue phenomena have resulted in important contributions being made to our knowledge of the crystalline structure of metals. Mr. Gough's contributions have been in both these fields. His book is the first attempt which has been made in Great Britain to study the subject as a whole, and he has performed a valuable service in bringing within its scope a careful consideration of the experimental data published in many journals. Among the subjects dealt with in its ten chapters are repeated-stress testing machines, endurance limits of metals, elasticity and its relation to fatigue, the fracture of metals under statical and repeated stresses, theories of fatigue failure and methods of rapidly determining fatigue ranges. It deserves to be widely studied by engineers and metallurgists.

(2) Not unrelated to the previous work is that by Dr. Georg Sachs on "The Mechanical Technology of Metals." This also is a book written by an engineer, a member of the staff in the Kaiser-Wilhelm-Institut für Metallforschung. The first section is concerned with the mechanical behaviour of solid metals, especially with reference to elastic properties, changes of form, tensile, compression, and torsion tests, cohesion and hardness. Then follows a consideration of metallic crystals and their properties. Upwards of twenty pages are devoted to the special properties of single metallic crystals. These are contrasted with the properties of crystalline aggregates in the following section. The author states that in their elastic behaviour, single crystals are sharply differentiated from crystal aggregates in that they are free from hysteresis, and in support of this quotes the work of Wartemberg and Geiss on the crystals of tungsten and zinc. Later sections deal with methods of hardening and softening and a consideration of theories put forward to account for these phenomena. The last section of the book treats of some special properties of pure metals and alloys. The author is an engineer who has evidently been quick to appreciate the fact that there are great possibilities of new knowledge being obtained in the study of the mechanical properties of single metallic crystals.

H. C. H. C.

Our Bookshelf.

The Physics of the Developed Photographic Image. By F. E. Ross. (Monographs on the Theory of Photography, No. 5.) Pp. 217. (New York: D. Van Nostrand Co.; Rochester, N.Y.: Eastman Kodak Co.; London: Kodak, Ltd., 1924.) n.p.

IN 1921 the Eastman Kodak Co. commenced the publication of monographs on the theory of photography, and this book by Mr. Ross is the fifth of the series. The work will appeal chiefly to astronomers and those interested in astronomy, since it is mainly with the questions of astronomical photography that the author is concerned. It is divided into six chapters which deal with "The Developed Silver Grain," "Graininess," "Astronomical Photographic Photometry," "Sharpness and Resolving Power," "The Mutual Action of Adjacent Images," "Film Distortion

and Accuracy of Photographic Registration of Position." Throughout the book the historical development of the subjects treated has been emphasised in a way that makes it easier for the reader with no previous knowledge of the subject to understand the fundamental problems involved. The chapter on graininess, by A. C. Hardy, is exceptionally well written, and should be of interest to all those engaged on problems involving great magnification of photographic negatives, as in cinematography. Chap. ii. contains a vast amount of information on the methods of astronomical photographic photometry, *i.e.* the method of obtaining the magnitude of a star from its image as impressed on the plate, and, with the remaining chapters, shows to the reader what a host of pitfalls and difficulties in astronomical photometry arise owing to the complicated structure of the photographic plate.

Mr. Ross is to be congratulated on having brought together into one volume a mass of information largely unknown to the average photographic worker, and of great value to the astronomer. The criticisms which can be made are not serious. In a volume with such a comprehensive title one would have expected to find the question of light scatter by the negative treated in relation to the well-known fact that the photographic density depends on the degree of diffusion of the light, etc.—a fact which has caused uncertainty in density measurement ever since it was introduced in 1890 by Hurter and Driffield. The more mathematical parts of the book suffer in the same way as most of these monographs have done, though not to the same extent as some, in that the text is sometimes difficult to follow. The photomicrographs are very fine; especially will they be appreciated by those who know the difficulty of photomicrography at high magnification of cross-sections of emulsion layers. F. C. TOY.

College Manual of Optics. By Lloyd William Taylor. Pp. ix+236. (Boston, U.S.A., and London: Ginn and Company.) 12*s.* 6*d.* net.

THE co-ordination of laboratory and class work is usually a problem of much difficulty in physics courses above intermediate standard, so that not infrequently there is little if any attempt made in this direction. The manual under notice sets out to bridge the gap between the two lines of study. It would obviously be impossible to treat both comprehensively in one volume of reasonable dimensions, and probably the most serious criticism to which the book could be subjected would be in respect of the matter omitted from it. Undoubtedly the most interesting section is that dealing with diffraction and interference effects observed with one and two slits. The essential differences between the two phenomena are clearly brought out, and Michelson's astronomical application of the latter is for once intelligibly presented and, further, strikingly illustrated by a laboratory experiment. The section on the Michelson interferometer is particularly good, as one has a right to expect from a book associated with the University of Chicago. Yet curiously enough there would appear to be no mention of the remarkable achievements of the instrument in optical testing work. The Fabry-Perot interferometer receives something less than adequate treatment; the student would probably obtain a quite erroneous idea of the relative importance of the two instruments in modern high-resolution work. The echelon spectroscope is not even mentioned, but no doubt this is because it is not usually met with in a laboratory course.

There are one or two points in the chapter on polarimetry to which exception can be taken. For example, the Laurent polariser (which is described here) has long given place to the Lippisch (which is ignored) as a research and commercial instrument. Again, contrary to what is stated, a yellow light filter is indispensable when a sodium flame is employed as source, at any rate for considerable rotations. It is surely not permissible to employ white light and a filter in any polarimetric measurements; the filter which will supply even approximately monochromatic light under such conditions has unfortunately yet to be invented. But these are minor blemishes, more than counterbalanced by many merits. It is a stimulating and original book, refreshingly lucid and direct in its methods, and provides without doubt a very valuable supplement to the ordinary text-books of optics.

The Central Caribs. By William Curtis Farabee. (University of Pennsylvania: The University Museum. Anthropological Publications, Vol. 10.) Pp. 299 + 40 plates. (Philadelphia: University Museum; London: Bernard Quaritch, Ltd., 1924.) 44*s.* net.

THIS sumptuously equipped and splendidly illustrated volume has all the virtues and some of the defects of the so-called "survey-work," that is, work carried on over an area very extended, relative to the time devoted to its study. Hence the traveller, unable to learn the native languages, has to rely on interpreters and informants, he has to collect material objects and to be satisfied with observations which can be made rapidly and yet correctly. It is possible in such work to obtain a clear idea of the material culture of a tribe and a general view of their beliefs and social organisation; to map out the differences between the peoples of the region studied; to signal strange customs of outstanding importance. The insight into the native ways of life and modes of thought, however, the intimate perspectives of their moral outlook, of their *Weltanschauung*, and of their social order are given only to those who have the opportunities and the patience indispensable for the study of the local idioms and for a life led among the natives.

Dr. Farabee has carried out his survey work among the Central Caribs exceedingly well. One tribe, the Macusi, were studied in some detail, the information about them taking up some three-fifths (about 140 pp.) of the text, while the remaining twelve tribes are dealt with on some 100 pages. The material culture of the Macusi is described at some length, and this part of the contribution is naturally the most satisfactory. Under the heading of "Social Culture" we find such subjects as clothing and ornamentation; music, dances and games; magic, belief and mythology, while only one page is devoted to "political organisation," and a few pages to marriage, family and kinship, *i.e.* the really sociological themes. This is natural, for sociology can be studied only very inadequately in survey work. But every statement found in this book is clearly

formulated and well documented, and we are throughout inspired with full confidence that the writer has not gone beyond what well-founded evidence warranted him to say. This is the line of demarcation between worthless amateur gossip about "savages" which has been the bane of anthropology, and genuine scientific information, such as is given in the present volume.

B. M.

Cours de Physique a l'usage des élèves de l'enseignement supérieur et des ingénieurs. Par Prof. Jean Becquerel. Tome premier: Thermodynamique. Pp. ix+430. (Paris: J. Hermann, 1924.) 25 francs.

THIS massive volume forms the first of a series of seven in which Prof. Becquerel proposes to deal with the various branches of physics. One cannot but feel awe as well as admiration at the boldness of such an undertaking, but if the remaining volumes reach the standard here set, the author must indeed receive our congratulations on a truly monumental work. Having faithfully accomplished the task of cutting the 430 pages of the present instalment, the reviewer would earnestly request the publishers to amend their methods by subjecting the remaining volumes to the guillotine.

The author believes that in the idea of energy and in the principles of mechanics may be found a guiding line which should never be abandoned. In the introduction he is careful to insist on the *experimental* basis of these principles, which are presented under an aspect compatible with recent progress in physics. Before beginning the exposition of thermodynamics, which has evidently been greatly influenced by the work of Planck and of Poincaré, the author discusses the discontinuous structure of matter and the kinetic theory of gases, acknowledging his indebtedness to the books of Eugène Bloch and of Jean Perrin. By the aid of the kinetic theory and the idea of the disordered movement of the molecules, the principle of Carnot is rendered less abstract. The statistical theory of thermodynamics, in which the author follows closely an exposition given by Langevin, gives precision to this idea.

As a descriptive treatise the book is an excellent one; the difficulties and mistakes of the student are carefully considered, but a British engineer would expect to find more attention paid to the numerical application of the theoretical results. H. S. A.

The Atmosphere and its Story: a Popular Presentation of the Science of Meteorology, free from Technicalities and Formulæ. By Ernest Frith. Pp. 204+9 plates. (London: The Epworth Press, 1924.) 6*s.* net.

IN his preface the author explains that this book is the outcome of daily explanations of the weather given to classes in meteorology at Clark University. The notes of these classes, collected and amplified, are here presented in book form.

The book is divided into four parts, one for each season of the year, the first section of Part I. giving a few brief notes on methods of observation of wind, temperature, humidity, rainfall, and snowfall. There follows a simple account of various physical processes in the atmosphere, supplying answers to many of the questions concerning the weather which strike the intelligent man in the street. The author writes in the first place for Americans, and the details he discusses are the details of American meteorology. In spite of this, however, his book can be recommended to the general English reader as a useful introduction to weather phenomena. It is very well illustrated, the cloud pictures being in all cases selected from the U.S. Weather Bureau's new cloud chart.

The author discusses in an interesting and instructive manner the rôle of moisture in the air, and the formation of fog, cloud, and rain. The topics in each seasonal part are selected so as to appeal to the general reader, and discussed in such a clear manner as to instruct that reader in the physical processes which underlie weather. The author has succeeded in writing a book which should appeal to a very wide public.

Electric Cables, their Design, Manufacture and Use: a Series of Lectures delivered in the Moore School of Electrical Engineering of the University of Pennsylvania. By William A. Del Mar. Pp. vii+208. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1924.) 12*s.* 6*d.* net.

THIS treatise gives a good account, both historical and scientific, of cable manufacture. Wire was originally made by beating metal into plates, which were then cut into strips and rounded by hammering. It is stated that the art of drawing metal through dies was probably invented in the fourteenth century, although it did not come into practical use in Great Britain before the second half of the seventeenth century. The Birmingham Wire Gauge was the first attempt to standardise sizes. The first scientific attempt was made by Brown and Sharpe in America in 1855. The diameters of the wires they fixed form a regular geometrical progression from the English size of No. 36 (5 mils) to 4/0 (460 mils). As there are 40 sizes, the common ratio is the 39th root of 92, which is 1·123 nearly. This gauge is now officially called the "American Wire Gauge."

It is interesting to see that the formulæ first given in Fourier's "Théorie analytique de la chaleur" are in everyday use in cable work. Approximate values of the thermal conductivities of all the ordinary insulating materials used for cables are given, and the question of the grading of cables so as to enable them to resist puncturing by high voltages is discussed at length. There is, however, a great deal of work still to be done, both by the mathematician and the physicist, before definite conclusions as to the value of the method can be reached.

Crystals and the Fine-Structure of Matter. By Prof. Friedrich Rinne. Translated by Walter S. Stiles. Pp. ix+195+15 plates. (London: Methuen and Co., Ltd., 1924.) 10*s.* 6*d.* net.

THIS translation has been made from the second edition of Prof. Rinne's book on fine-structure of matter, which he has named Leptology (λεπτός). According to the preface the book was written largely for the general reader, but discussion of a large number of aspects of the subject (there are fifteen chapters) has necessitated much condensation, and it is doubtful if much of the matter will be intelligible to the layman. This is noticeable in Chap. iii., "Crystallography and

Leptology," in which all the standard X-ray methods and the general morphology of crystals are outlined in thirty pages. The matter is very well selected and furnishes most stimulating reading; the book should prove most useful as an introduction to a detailed study of any aspect of crystallography. The later chapters, dealing with crystals and chemical reactions, are particularly suggestive.

The book is well illustrated, though there is, on occasion, insufficient reference to diagrams in the text. There are some excellent photographs of prominent crystallographers. There are constant references to the authors of fundamental researches; authors of other than German nationality receive perhaps rather less than their share of credit. A suggested addition is that references to original sources should be included for some of the more fundamental work; it is, for example, difficult to form a clear picture of the methods of Polanyi and Schiebold from the few sentences given them in the book.

Tudor Economic Documents: being Select Documents illustrating the Economic and Social History of Tudor England. Edited by R. H. Tawney and Eileen Power. (University of London Historical Series, No. 4.) In 3 vols. Vol. 1: Agriculture and Industry. Pp. xiii+383. Vol. 2: Commerce, Finance and the Poor Law. Pp. ix+369. Vol. 3: Pamphlets, Memoranda and Literary Extracts. Pp. viii+486. (London: Longmans, Green and Co., 1924.) 15*s.* net each.

IT is difficult to see how a better selection of material than this could well have been made. In three volumes the editors give us documents from every conceivable source, chroniclers, pamphleteers, close rolls, court records, which illustrate every aspect of economic life in the changing epoch of Tudor England. They are not of interest to the economic historian alone; the student of literature and of social life will find much to interest him. The English itself is, often enough, of that stately texture which reached its highest point in the stiff splendour of Sir Thomas Browne; and ballads like "Nowe a Dayes," and Bastard's epigrams, are of the very heart of a great folk-thought. Special attention should be directed to the important, and hitherto unpublished, "Polices to reduce this Realme of England unto a Prosperous wealthe and Estate," which is one of those minor discoveries as noteworthy to reader as to editor. It is a pity that the plan of the series did not permit of an ample introduction. One would have given much to know the editorial view of a period they have illuminated so wisely. H. J. L.

Electrical Drafting and Design. By Calvin C. Bishop. Pp. vii+165. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1924.) 10*s.* net.

THIS book is intended to bridge the gap between what a man learns in a technical college and what he is required to do in the office of an engineer, a contractor, or a power company. He should have had a two years' course in mechanical drawing, a knowledge of technical electricity including cables and machines. He must also know the Wiring Rules and have some practical knowledge of wiring. After giving instruction about making practical drawings, special cases are considered, such as diagrams for three-phase panels, outdoor sub-stations, house wiring, etc.

The chapter on artificial illumination is very helpful. After defining the foot candle and the lumen a discussion of how the coefficient of utilisation and the depreciation factor affect the lumens required is given and formulæ are developed which enable these to be taken into account. The formulæ would not attract a mathematician, but as they take into account the dust and dirt which collect on the lamps, the ageing of the lamps as well as the coefficients of utilisation of the lumens by the various standard types of shades and reflectors which can be bought in shops, they are of practical value. Full descriptions are given of standard screws, bolts, copper rods, etc. We can recommend this book to the engineer.

La technique du vide. Par L. Dunoyer. (Recueil des Conférences-Rapports de Documentation sur la Physique. Vol. 7, 1re Série, Conférences 17, 18. Édité par la Société *Journal de Physique.*) Pp. 225. (Paris: Les Presses universitaires de France, 1924.) 15 francs.

THE volume under notice forms an important contribution to the study of high vacua, and its publication emphasises the great improvements which have been effected in experimental methods during the past ten years. Chap. i. deals with various types of pumps, special attention being given to molecular pumps and to mercury vapour pumps. Chap. ii. is concerned with manometers. Some miscellaneous questions, such as the construction of connecting tubes, the elimination of occluded gas, and the analysis of residual gases, are discussed in Chap. iii.; and the last chapter deals with the production or improvement of a vacuum by means of absorbing materials or the electric discharge. The author rightly attaches great importance to the work of Martin Knudsen on the flow of gas rarefied to such a degree that the mean free path of the molecules has become large in comparison with the diameter of the tube.

Modern Practice in Mining. By Sir R. A. S. Redmayne. Vol. 1: *Coal: its Occurrence, Value and Methods of Boring.* Third edition. Pp. xvi+231. (London: Longmans, Green and Co., 1925.) 10*s.* 6*d.* net.

THIS constitutes a new edition, the third, of the first volume of a series intended to cover modern practice in coal mining, this particular volume describing the occurrence and properties of coal, the methods of searching for coal by means of boring and deep boring in general. The body of the work has not been greatly altered from the previous edition, but an additional chapter has been inserted in which some modern appliances and devices for determining the deviation of boreholes are described. The consequence of this method of dealing with the subject is that the body of the work remains somewhat out-of-date. For example, the bomb calorimeter is not even mentioned, though it is to-day the most generally used appliance for determining the calorific power of coal. Although not a matter of technical importance, a protest may well be entered against such an irritating piece of false Latinity as "apparati."

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.*]

Copepods in the Northern Hemisphere.

IT has long been recognised that the distribution of freshwater copepods has been profoundly influenced by the incidence of the glacial period, since the lake-districts which they inhabit are to a large extent postglacial catchment basins. It so happens that there is a general correspondence between the three leading sub-orders and the three principal life-zones of lakes, namely, the creeping Harpacticoida of the littoral zone, the swimming Cyclopoida of the neritic zone, and the pelagic Calanoida of the open water. In the genus Cyclops there are upwards of twenty species common to the fauna of Norway (representing northern Europe) and of Germany (representing central Europe). Two significant differences are the absence of *C. capillatus* from Germany and the absence of *C. prasinus* from Norway, both of these species occurring in Canada.

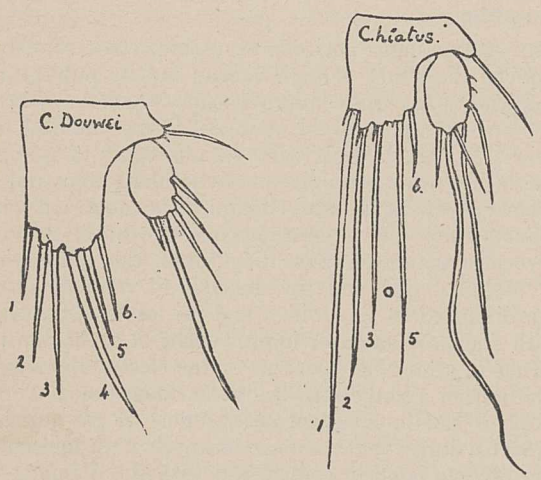

FIG. 1.—Fifth foot of female of *C. douwei* and *C. hiatus*.

The parallelism between the harpacticoid copepods in Europe and North America is remarkable. The writer has contributed to this subject in recent years, last year making the canoe trip to the great lake Mistassini, which lies beyond the Laurentian watershed and drains into Hudson Bay by the Rupert river. The genus Canthocamptus is intimately bound up with the Holarctic region, but the species are local and eclectic and they have to be searched for far and wide in likely places. The uncultivated area that occupies much of the northern portion of Canada offers a profusion of such places, pools, swamps, springs and quaking bogs, which are by no means easy to reach, but the offerings of the more accessible lakes are such as to stimulate one to plunge into the wilderness in quest of these insignificant inhabitants of the primeval sources. The rule is that they differ alike from each other and from their transatlantic relatives by clean-cut unit characters and, incidentally, they are frequently monogamous, thus exhibiting the phenomenon of segregation in all its phases.

The American forms differ, sometimes in the least apparent respect, sometimes in greater degree, from the European types, and this relation can be brought out by a tabular list, the knowledge of the items composing it being a secondary matter not necessary for the comprehension of the picture it presents. In two or three instances the differentiating characters are sufficiently intelligible to be mentioned. In *C. hoferi* the antennules are normal and 8-jointed; in its Canadian counterpart, *C. douwei*, they are 7-jointed. On the other hand, in *C. wierzejskii* the antennules are 7-jointed, and in the Canadian equivalent, *C. obatogamensis*, they are 8-jointed. Lastly, in *C. douwei* the fourth seta of the fifth foot is the longest of its set; in *C. hiatus* there is no fourth seta, and a gap, absolutely constant, is left for it (Fig. 1).

EUROPE.	NORTH AMERICA.
Canthocamptus staphylinus Jurine	*staphylinoides* A. S. Pearse.
,, *minutus* Claus	*minnesotensis* C. L. Herrick.
,, *vejdovskyi* Mrazek	*minusculus* Willey.
,, *arcticus* Lilljeborg	*subarcticus* Willey.
,, *hoferi* Douwe	*douwei* n.sp.
,, *fontinalis* Rehberg	*frigidus* Willey.
,, *northumbricus* Brady.	*northumbricoides* Willey.
,, . . .	*hiatus* n.sp.
,, *wierzejskii* Mrazek	*obatogamensis* n.sp.
Wolterstorffia confluens Schmeil	*Marshia albuquerquensis* Herrick.
Laophonte Mohammed Blanchard and Richard	*L. calamorum* Willey.

The above table does not exhaust the list of those that can be paired, and there are others which cannot be paired off. For example, *C. cuspidatus* Schmeil is represented here by an undescribed form (the new species named above are succinctly defined in this letter), while *C. illinoisensis* Herrick has no European double, but appears in the ultramontane lakes and springs of Canada in a new form, *C. hyperboreus* Willey (Trans. Roy. Soc. Canada, 1925, in the press).

ARTHUR WILLEY.

McGill University, Montreal,
July 9.

The Effective Wave-length of γ Rays.

IN his letter to NATURE (January 3, 1925, p. 13), Prof. Gray states: "If the secondary β-rays, produced in light elements by the hard γ-rays of radium-C, are recoil electrons, with energy given by the quantum theory of scattering, . . . the effective wave-length of the γ-rays must be much smaller than that usually accepted. Without going into details . . . no theory, as at present developed, can account for the properties of scattered γ-radiation."

By means of Wilson's cloud expansion method, I have observed the β-rays which are excited in gases by γ-rays hardened by 3 mm. of lead. It has thus been proved quite conclusively that these secondary electrons are recoil electrons, as predicted by Compton's quantum theory of scattering. These results, which Prof. Gray does not mention, permit me to draw some conclusions as to the effective wave-length of γ-rays.

I obtained photographs of β-ray tracks in a homogeneous magnetic field and calculated the velocities of different separate β-particles from the curvature of these tracks. The corresponding results may be found in *Zeitschr. f. Physik*, v. 28, p. 285, October 1924 (see NATURE, Dec. 6, p. 838).

If we assume that the effective wave-length of the γ-rays is equal to 0·02 Å.U. as usually accepted (that means $h\nu$ equal to about 600 kilovolts), then the maximum limiting velocity of the recoil electrons, according to Compton's theory, must be 400 kv. Now, I found that out of 72 electrons for which the velocity was measured, 69 had a velocity smaller than 400 kv. and only 3 electrons showed an energy surpassing this value (the swiftest of the latter had a velocity about 1000 kv.).

It seems to me that these results disprove Prof. Gray's statement: "If they are recoil electrons, the effective wave-length of the γ-rays must be taken as about 0·008 Å.U. in order that we may account, on the quantum theory of scattering, for their observed energy." (A wave-length of 0·008 Å.U. corresponds to a maximum energy of recoil equal to about 1300 kv.)

The main values of energy deduced from my data for electrons ejected at different angles to the primary ray also account for the usually accepted value (0·02 Å.U.) of the effective wave-length. I may add that this order of value is confirmed by new measurements of Amahd and Stoner (Proc. Roy. Soc. 106, 17, 1924), who found 0·019 Å.U. as the upper limit of effective wave-length.

It may be hoped that the direct counting of β-rays, and the measurement of their velocity, will give a distribution of intensity in the γ-ray spectrum which differs from that obtained by the usual method. By intensity is here meant the number of elementary quanta of γ-rays, and not, as is usual, their energy.

Ellis (Proc. Camb. Phil. Soc. 22, p. 374, 1924) obtained the γ-ray spectrum of radium-C, where the most intense line (in the above meaning) seems to correspond to a wave-length of 0·02 Å.U. A strong line E34, lying near the limits of the spectrum ($\lambda = 0{\cdot}00867$ Å.U.), is twice less intense, and, according to Compton's theory, much less effective as to the production of recoil electrons.

As to my disagreement with Prof. Gray, I may state the following. The method used by me has the advantage of making it possible to observe the undisturbed spectrum of secondary β-rays, which are produced directly in the gas. In the case of a screen being the source of secondary β-rays, the distribution of velocities will be altered owing to the absorption of the rays in the screen itself; if we want to observe an undisturbed spectrum by the usual method, we ought to have β-rays excited in very thin layers of matter, which may be impossible so far as light elements are concerned.

On my photographs there may be seen not only the tracks of the β-rays produced in the gas, but also the tracks of those rays which take their origin in the 2 mm. thick wall of the chamber; in this case, we observe the secondary corpuscular radiation of the wall which is "hardened" by the wall itself, and the photographs show the presence of a comparatively larger number of swift electrons (most of these photographs show tracks of particles the velocities of which approach 1000 kv.).

D. SKOBELTZYN.

The Polytechnical Institute,
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June 29.

Further Spectra associated with Carbon.

DR. R. C. JOHNSON, in an article with the above title which has just appeared (Proc. Roy. Soc., A, 108, 343, June 1925) has given in his Table IV. a set of six new double-double headed bands, degraded to the violet, and associated with the comet-tail spectrum, which is also double-double headed, but degrades to the red. I find that these new bands have the same set of initial vibration states as the first negative group of carbon, and this, in connexion with the relation stated in my letter of June 8 to NATURE, published in the issue of August 1, that the set of final states of the first negative group and of the comet-tail bands is the same, leads to relations of considerable importance in the quantum theory of band spectra.

In the first place, the final states of the new bands must be identical with the initial of the comet-tail bands. This is in fact the case, using the assignment of vibrational quantum numbers given in the letter just quoted. This proves the correctness of that assignment and shows that the weak λ5281 band omitted in that assignment, as well as the weak λ5764 and λ6354 bands, are not a part of the regular group. The values of the vibrational quantum numbers n'-n'', for Johnson's six bands, in the order listed by him, are 0-1, 1-2, 0-0, 1-0, 2-0, 3-0. Secondly, the frequency of the "origin" of the new Johnson group must equal the difference in frequency of the origins of the other two groups. This also is accurately true, provided one uses Baldet's (*Comptes rendus*, 180, 820, 1925) series interpretation of the comet-tail bands, and Blackburn's (Proc. Nat. Acad. Sci., 11, 28, 1925) of the first negative group.

More generally, from measurements of the frequencies of the individual lines of the comet-tail and first negative group bands, one can calculate immediately the frequency of *every line* of every band of the new group, *provided* the structure of the bands of the various groups has been properly interpreted, in working out the systems of energy levels. It is this last fact which makes the above relations of such importance, for there is at the present time a sharp difference of opinion concerning the interpretation of a number of vital points in connexion with the series structure of complex bands such as these. A fine structure analysis of Johnson's new bands should allow a definite decision on a number of these points.

Without any further data, however, it is possible to decide definitely that the comet-tail bands have a *double* electronic level in the initial state, of spacing $\Delta\nu = 126$. Each of these bands has a double "origin" given by the heads of the two Q branches, according to Baldet's (*loc. cit.*) analysis, thus confirming this analysis in contradiction to Blackburn's (*Phys. Rev.*, 25, 888, 1925) quite different interpretation. Similarly the new bands each have a double origin with the same spacing ($\Delta\nu = 126$). This double origin is the second and fourth "head," counting from the *red*, while in the comet-tail bands it is necessarily the second and fourth head, counting from the *violet*. As might be expected, the theoretically inconsequential spacing of the first and second heads, second and third, etc., in each band is not at all the same for the two groups, but the spacing of these two Q branch heads ("origins") is precisely the same.

Other points at issue relate to the application of the combination principle to the rotational energy levels, the question of one-half versus one-quarter values of electronic momentum, the numerical magnitude of the moment of inertia, etc. They cannot be discussed in a brief communication like this, but Dr. R. S. Mulliken, in an article just sent to the Proc. Nat. Acad. Sci., mentions some of the difficulties of interpretation in the case of these particular band groups.

RAYMOND T. BIRGE.

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On the Theory of the Zeeman Effect.

IN his letter to NATURE of June 27, p. 978, Prof. W. M. Hicks points out that the theory of the Zeeman effect on the application of Larmor's theorem is no explanation, and concludes that the theory of the Zeeman effect on the quantum basis yet remains to be given.

I may say that the classical theory can still demonstrate the Zeeman and Stark effects. In the Proceedings of the Pont. Academy of Sciences (March 1923) I

proposed a theory for both effects as a problem of perturbation in electron orbits, and last August I presented the same at the International Mathematical Congress at Toronto.

In the simplest case of circular orbits due to a central force (Coulomb's force) represented by the equations in polar co-ordinates

$$\frac{d^2r}{dt^2} - r\left(\frac{d\theta}{dt}\right)^2 = -\frac{\mu}{r^2}; \quad \frac{1}{r}\frac{d}{dt}\left(r^2\frac{d\theta}{dt}\right) = 0$$

we can introduce a perturbing force X due to a magnetic or an electrical field, and determine the variations produced in the characteristic quantities. For the primitive (non-perturbed) radius of the circular orbit, the X force introduces a correction ρ given by the equation

$$d^2\rho/dt^2 + n^2\rho = 3X \cos nt,$$

n being the average time of astronomers. We can integrate the equation in every hypothesis and deduce the variation of the periodic time n. Let X be the effect of a magnetic field H, then ρ results, $\rho = \pm evH/mcn^2$, e, v, m, c being well-known quantities, and the primitive periodic time becomes $n = n_0 \pm 3eH/2mc$, containing the explanation of simple Zeeman triplet.

If we assume the central force to be an elastic force, the solution becomes $n = n_0 \pm eH/2mc$, the well-known Lorentz's formula.

The more complex Zeeman effects may be deduced from elliptical orbits, and the solution gives also a displacement of perihelion in terms of classical methods.

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Gregoriana University,
Rome.

Science and Intellectual Freedom.

MR. WELLS'S letter in NATURE of July 25, p. 134, fails to notice a most important distinction. Knowledge concerning the origin of species may be, and usually is, honestly and honourably desired for its own sake without any view of practical application. Knowledge concerning contraception is sought, either from mere prurience, or from intention to practise it or to teach others to do so. Many who hold that the State has no right to control its members' thoughts hold that it has the right to control their actions; and such persons, if they hold (as I do not) that the prevention of conception is wrong, may oppose the propagation of knowledge which has no value except in so far as it leads to such prevention, without being insincere in their desire for intellectual freedom.

There are, of course, doctrines, especially in ethical, political and economic theory, the intellectual and practical values of which are so closely associated that it is difficult to decide into which class they fall. But the solution of the problems raised by these border-line cases—which are those that cause real difficulty—is not aided by a refusal to recognise that they are border-line cases, and that the classes which they separate are generally distinct and present no difficulty whatever to a judicial mind.

NORMAN R. CAMPBELL.

The Isotopes of Mercury.

THANKS to generous financial assistance, for which I am indebted to the Department of Scientific and Industrial Research, I have been enabled to build a mass-spectrograph giving double the dispersion of the one previously in use. The final adjustments of this instrument are by no means complete, but it has already given results of great promise.

Preliminary photographs of the mass-spectra of mercury show its lines clearly resolved and so enable a definite statement to be made on the mass numbers of its most important constituents. These are six: 198 (4), 199 (5), 200 (7), 201 (3), 202 (10), 204 (2). The numbers in brackets indicate very roughly the relative intensity of the lines and, if we assume the whole number rule to be exact, correspond to an atomic weight in agreement with the accepted chemical one, 200·60. The possibility already suggested (*Phil. Mag.*, 49, p. 1196, 1925) that the mercury group might show a resemblance to that of cadmium is therefore borne out to some extent, although the extreme variation in the intensity of its lines appears rather less than in that element. On several of the mass-spectra obtained there are faint indications of other lines, but a great deal more work will have to be done before these are proved to be due to isotopes of mercury or not; in any case their proportions are comparatively insignificant.

These results have a direct bearing on the claims recently made that under special conditions mercury has been transmuted into gold by the addition of an electron to the nucleus. It is clear that if the gold were so formed it would have an atomic weight at least as high as 198, that is, perceptibly higher than that of ordinary gold, 197·2. A definite determination on this point would seem to provide conclusive evidence on this interesting problem.

F. W. ASTON.

Cavendish Laboratory, Cambridge,
August 1.

Separation of the Depressor Principle from Hepatic Tissue.

THE action of water-soluble substances prepared from hepatic tissue in lowering the blood pressure of normal animals has been noted in the literature for many years. Investigations as to the chemical nature of this principle, which were initiated in this laboratory and the Department of Physiology eighteen months ago by Drs. James and Laughton, have yielded the following results.

The active principle is non-protein in character and is found in the abiuret fraction. It is soluble in water-alcohol solutions up to 80 per cent. strength. It is precipitated from aqueous solution by phospho-tungstic acid along with the diamino acid fraction, and the material recovered in aqueous solution can be further purified by extraction with ether, which has the capacity for dissolving out a very active principle which depresses the arterial tension and maintains it at a subnormal level for a long period.

The depressor substance is associated with a pressor principle in the abiuret fraction. These two are separated during the treatment with phospho-tungstic acid, since practically all the pressor element remains in solution.

Not only is the normal pressure reduced to subnormal levels but also artificial hypertension, induced by various well-known pressor substances, is similarly reduced to any desired level depending on the dose employed.

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The Problem of Stellar Evolution.

By Prof. H. N. RUSSELL, Princeton University Observatory.

THE great problem of the evolution of the stars may be attacked along two main lines. We may study the properties of the stars themselves, as revealed by observation, and find orderly sequences among them; or we may analyse, on general physical principles, the constitution of a mass of gravitating matter, and the probable sequence of its changes.

Advances on these two fronts have shown a certain tendency to alternation. Lockyer's conception of stars of rising and falling temperature was based mainly on general physical considerations. The recognition of the sequences of giant and dwarf stars lent strong support to this theory, and—as the present writer showed some eleven years ago—a great mass of observed details fits in with remarkable completeness with the idea that the stars rise in temperature until the gas in their interior becomes compressible only with difficulty, and then cool down again.

More recently, progress has been mainly on the theoretical side, and has been very rapid. Among the milestones on the way may be noted the application of the theory of radiative equilibrium to the internal constitution of the stars, the appreciation of the fundamental importance of radiation pressure in this equilibrium, and of ionisation in making the mean molecular weight low and almost independent of chemical composition—then, recently, the development of rational, rather than empirical, expressions for the elusive opacity-constant, and the recognition that the dismembered atoms inside the stars are so small that even at enormous densities the material must behave like a perfect gas. Several investigators—Jeans, Kramers, Eggert—have contributed to this field, but much the largest share is Eddington's.

Meanwhile, observation has established conclusive evidence—with the joint help of astronomy, physics, chemistry, geology, and biology—that the life of the sun must be enormously long, and that the stars must have within themselves some vast store of potential energy, of hitherto unimagined extent.

These new developments must obviously lead to changes in the theory of stellar evolution to which reference was made above. One frank, but not unfriendly, critic recently characterised these changes as "sudden death." The writer—remembering Mark Twain's response to the rumour of his own demise—believes that in this case, too, the reports have been "greatly exaggerated."

On one point there can be no possible doubt. The feature of the older theory which assumed a fall of internal temperature in the denser dwarf stars owing to the close-packing of the atoms, must be finally abandoned. Eddington's argument is conclusive, and it is clear that the low surface temperatures of these stars must be ascribed, not to low internal temperatures, but to the increase of opacity with density, which prevents the heat from leaking out quickly to the surface.

The theory of the internal constitution and the luminosity of the stars is now really in a fairly satisfactory state. The relations connecting the mean molecular weight and the opacity-constant with the temperature and density appear to be well enough known to assure us that the approximations used by Eddington and Jeans must be close to the truth. Only one quantity remains uncertain—η, which represents the ratio of the average rate of generation of heat per gram in the portion of the star within a given distance of the centre to the corresponding quantity for the whole star—and Eddington has just shown that great changes in the law of its increase toward the centre affect the surface characteristics of the star but little.

Though approximations must be made in the solution of the equations, and opinions differ as to which is best, the main results are clear. The luminosity of a star (its total radiation) increases rapidly with increasing mass, but changes relatively little with the surface temperature, so that the influence of the latter may be expressed by a subsidiary correction—which rarely, if ever, reaches one magnitude, if the solar type is taken as standard.

The new theory, therefore, indicates that a star of given mass must be not far from a definite absolute magnitude, but may have any radius, surface temperature, and spectral type (the old restriction to densities less than a certain limit being unfounded).

The first of these conclusions is strikingly confirmed by observation, both for the most accurate individual data and for averages covering all the available material.

The second, however, is in definite disagreement with the facts. The stars of a given mass—or a given absolute magnitude, which are far easier to pick out, and afford an equally good test of the theory—are by no means indiscriminately distributed among the various spectral classes.

Among the brightest stars, it is true, all spectra are found; but among stars of not more than ten times the sun's luminosity, a large majority of those of given brightness are found within narrow spectral limits. Observational selection is much less disturbing if the grouping is made in this way, and there can be no doubt of the reality of the phenomenon.

From this viewpoint the stars may be divided into three groups:

1. The main sequence (a name suggested by Prof. Eddington), for which the luminosity diminishes rapidly, with increasing redness. This sequence includes most of the O, B, and A stars and all the ordinary dwarfs, and represents the most pronounced axis of concentration of the points upon the familiar diagram in which absolute magnitude is plotted against spectral type.

2. The giants—lying on the bright side of the main sequence, with representative points widely scattered, but showing a fairly definite axis of concentration, joining the main sequence near class F, and running somewhat upward for the redder stars.

3. The white dwarfs, of low luminosity and high surface temperature. Few such stars are yet known, but there are three of them within six parsecs, and they must be more abundant per unit volume of space than any other class except the K and M dwarfs.

Fig. 1 shows the relations for twenty typical stars (taken mainly from Eddington's list). Nos. 6 to 18 clearly indicate the main sequence. Nos. 1 to 5 give a sketchy idea of the giants, and 19 and 20 are the most notable white dwarfs.

To account for this distribution, something more than the internal equilibrium of the stars must be considered. The problem is intimately bound up with that of the source of stellar energy, and the probable secular diminution of stellar mass.

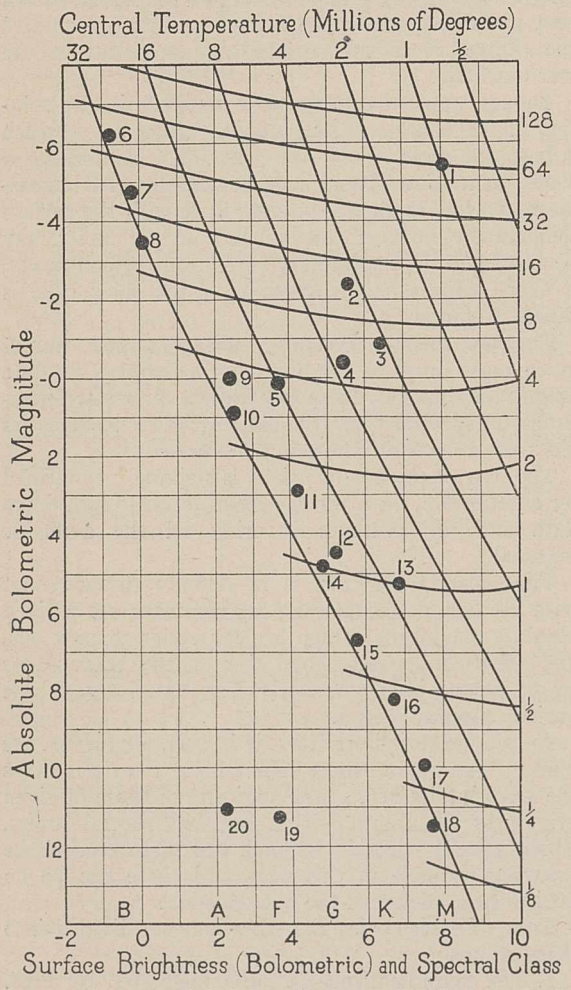

Fig. 1.—1, Antares; 2, δ Cephei; 3, Arcturus; 4, Capella A; 5, Capella B; 6, Plaskett's star; 7, V Puppis; 8, Y Cygni; 9, β Aurigæ; 10, Sirius A; 11, Procyon; 12, α Centauri A; 13, α Centauri B; 14, sun; 15, ξ Bootis A; 16, ξ Bootis B; 17, Kruger 60 A; 18, Kruger 60 B; 19, Sirius B; 20, O_2 Eridani B.

All commentators agree that if the mass of a star remains nearly constant throughout its history, no comprehensive scheme of evolution appears to be possible. But, if the major part of the mass can ultimately be transformed into energy and radiated away, the problem becomes more hopeful.

The first question to be considered is whether the rate of transformation of matter and generation of heat within a star is independent of the temperature and pressure, or not. If the former is true, the star must expand or contract until the rate of loss of heat from the surface balances the unalterable income; if the latter, until the rate of production balances the loss.

An accumulation of heat inside a gaseous star compels its expansion. Unless this is accompanied by an increase of the loss of heat from the surface, a star of which the internal income of heat is fixed cannot be in stable equilibrium. Even if the outgo balanced the income at the start, the slightest deviation would go on increasing, until the star either expanded indefinitely or contracted to minute size. Now recent theory indicates that it is very probable that increase in diameter, and fall of surface temperature, go with decrease in total radiation. Hence, as Eddington points out, the theory that the rate of generation of heat is independent of the internal conditions appears to be untenable.

If this rate varies with the temperature (or perhaps with the density) it is practically certain that it must increase rapidly as the temperature rises—for there is certainly no considerable generation of heat inside the earth. In this case the expansion of the star lowers the internal temperature, and cuts off the excess supply of heat; and the adjustment to such a condition that just enough heat is generated to supply the leakage to the surface will be automatic and stable.

It appears, therefore, necessary to conclude that the rate of transformation of matter into energy increases with the temperature. The thermodynamic difficulties in the way of this hypothesis are serious, but probably not insuperable.

Here, however, we can no longer call our present knowledge of the general properties of matter to aid in solving the specific problem; rather we must once more be guided by the observed astrophysical data.

The two sets of curves in Fig. 1 are computed from Eddington's theory (Monthly Notices, R.A.S., 84, 104, and 308, 1924) (taking fuller account of the probable change of molecular weight) and represent stars of fixed mass or fixed central temperature.

It is at once obvious that all the stars of the main sequence have very nearly the same central temperature—about thirty million degrees. A theory based on different approximations might not make these temperatures come out so remarkably alike, but would still leave them very similar. The giants are cooler inside, and the white dwarfs must be hotter, though numerical calculations are unsafe for such great densities.

The concentration of stars along the main sequence can now be simply explained by assuming that, in the neighbourhood of a temperature of about thirty million degrees, the rate of transmutation of matter into energy increases very rapidly. A higher central temperature than this would generate heat faster than it could escape, the star would expand and cool, and, practically, it could not pass this limit. One would expect the internal temperature to be somewhat higher for the stars of great luminosity (which radiate more heat per gram). An entirely permissible change in the constants of the theory would allow this.

If all the matter in the stars behaved in this way we should expect a star to pass through the giant stages precipitately, since the generation of heat at lower internal temperatures would not suffice for equilibrium. This is evidently not the case, so that it is necessary to postulate that there are also one or more forms of matter which are transformed at lower temperatures,

and supply the "fuel" for the giants. Some highly refractory constituent seems to be indicated by the white dwarfs.

The first stage of a star's history which can be clearly visualised is, then, a sphere of very rarefied gas, comparable in diameter to the orbit of Uranus or Neptune, and with a central temperature of a few hundred thousand degrees. Losing heat by radiation, it contracts, at first very rapidly, drawing upon its gravitational energy. When the central temperature reaches some critical value—probably rather less than a million degrees—the degradation of some form of matter (either wholly into energy or into some less massive form, with corresponding energy-emission) begins, and a star is born. The rate of evolution now depends on that of the exhaustion of the transformable material, and, as this is used up at the centre, the star must slowly contract so that the temperature rises, and new regions, nearer the surface, become the main seat of the transformation.

If, as von Zeipel believes, and Jeans doubts, there is active mixing by radial convection, the region of transformation will be less localised, but the general result the same—the temperature rising, as the quantity of exhaustible material diminishes, in order to keep up the rate of liberation of heat. Several successive processes of this sort, involving the transformation of various kinds of matter with different critical temperatures, may be operative during the giant stage.

We must next suppose that as a temperature of some thirty million degrees is approached, a process comes into play which leads to the actual annihilation of the main mass of the stellar material, with a correspondingly great liberation of energy. The central temperature will then remain nearly constant, and the star steadily decrease in mass, "burning itself away" at the hot centre, gradually growing dense and more opaque, and passing down the main sequence.

Finally, to account for the white dwarfs, we must believe that there exists a certain residue of refractory material, immune to transformation at thirty million degrees. As the main constituents become exhausted this will preponderate, and at last be almost exclusively present. If this residue were incapable of transformation, rapid gravitational contraction would ensue until even the ionised atoms were jammed close together. The considerable abundance of the white dwarfs per unit of volume suggests, however, that further energy-liberating changes occur and delay the last act.

The course of evolution would then be represented, on the familiar diagram, not by a reversed figure 7, but rather by a reversed letter *Z*. During the giant stage the surface temperature rises, and the representative point moves to the left. Then along the main sequence it falls, and the point moves downward and to the right. Finally, the star becomes a white dwarf, the temperature rises, and the point moves to the right again.

Whether the lines representing the giant and the white dwarf stages run nearly horizontally, or downward to the right, depends upon the loss of mass in these stages—that is, upon the quantity of matter available for transformation within the corresponding ranges of temperature. The large number of the giants suggests that a considerable fraction of a star's mass is lost during these stages, and that the evolutionary line slopes downward.

If the easily transformable material becomes nearly exhausted before the main transformation sets in, there will be a period of relatively rapid change between the redder giants and the main sequence, and such intermediate stars will be statistically infrequent, as appears to be actually the case.

Too few white dwarfs are known to justify a similar discussion.

It should be especially noticed that while, on the theory here proposed, all stars should pass along at least a part of the main sequence, they may be very different in the other stages. A star of great initial mass would give an evolutionary line crossing the diagram near its top, and joining the main sequence at class B or class A. One of small mass might come in at F or G, or even lower. The existence of such stars, intermediate between the redder giants and dwarfs, is therefore no argument against the theory either in its present form, or for that matter, in the older and abandoned one.

The fainter component of α-Centauri—as Fig. 1 shows—seems to be a star of this sort, and, from the present viewpoint, would be classed as a giant of small mass (as must also be the large red companions of such eclipsing variables as U Cephei).

Similarly, the level at which a star would break away from the main sequence, and become a white dwarf, would depend on the quantity of "refractory" matter originally present (or perhaps formed as a by-product of other transformations), and any combination of absolute magnitude and spectral type is possible.

This scheme of stellar evolution is very similar to its predecessor. The only important point of difference is (as Eddington puts it) "that the diminishing brightness in the dwarf series is due to decreasing mass, and not to a falling off in compressibility." On the other hand, the difference of mass between giants and dwarfs is now explained, and the white dwarfs—formerly most puzzling—now, thanks to Eddington, find an orderly place at the end of the sequence.

The notion of the transmutation of mass into energy, upon which the new theory is founded, appears to rest upon strong evidence. The specific types of transformation postulated above are frankly adopted *ad hoc*, as indicated by the observed statistical facts; but while the subject is still outside the range of existing theories of the constitution of matter there is nothing else to do; and so far as can be judged, the postulates seem plausible enough.

The youngest known stars (not in years, but in evolution) appear to be those of class N and Me, and it is probably no accident that practically all of these are variables. The latest known stage, judging by the density, is found in the companion of Sirius. This is abnormally faint for its mass, and it may be, as Eddington suggests, that close-packing of the atoms is beginning to have an influence here (at a central density of the order of one ton per c.c.!).

The final stage is still uncertain. Either the loss of mass continues indefinitely until the star practically disappears, or else close-packing halts the rise of temperature, before the most refractory atoms can be

annihilated. In the latter case the star must ultimately cool down.

There seems little reason to suppose that it would ever return to a "normal" density. Ordinary matter, subjected when cold to increasing hydrostatic pressure, should break down to a state of far smaller volume in which the valence electrons wander freely, while the complete shells of electrons normally inside these approach almost to contact as soon as the work done by the compression exceeds the ionisation energy required to tear the valence electrons loose.

Further—and very great—increases of pressure should break down the *N*, *M*, *L*, and ultimately the *K* shell, and reduce matter to a formless state. Probably the greatest pressure which exists even in a white dwarf would not complete this process except for the lightest atoms; but the maintenance of a very high density, even if all the heat had been lost, appears entirely possible. Only the surface of such a body would be in the ordinary solid state; that of the interior would transcend our experience, but not our imagination.

Regions of Tension and Continental Drift.[1]

By Dr. J. W. Evans, F.R.S.

If the sima magma, when still in its original position under the heavy pressure of the superincumbent sial, remained at too high a temperature for crystallisation to take place, the magma and the rocks differentiated from it would be of the normal types. The temperature-gradient, however, in the great masses of sial (the continental shields of some authors) shows a relatively slow increase in depth; consequently, a comparatively low temperature may be found at their under surface, a temperature sufficiently low for some crystallisation to take place.

In these circumstances it may be expected that crystallisation will commence with those minerals or groups of minerals that have a small molecular volume; small, that is to say, for the elements which they contain. Corresponding to these there are usually minerals or combinations of minerals having the same chemical composition but greater molecular volumes, which crystallise under low pressures. Among the high-pressure minerals with small molecular volumes are garnet, zoisite, epidote, kyanite, muscovite, biotite, and diamond. The low-pressure minerals with large volumes include anorthite, orthoclase, andalusite, and graphite. Albite and water have relatively large volumes, but have for practical purposes no small-volume representatives.

Dr. F. Becke has shown [10] that igneous rocks, formed originally at moderate depths, have, when subjected to great pressure, certain minerals changed into others with greater density: for example, orthoclase into muscovite and quartz, and lime-soda plagioclases into albite and zoisite. He gives the following equation:

$$x(\underset{\text{albite}}{NaAlSi_3O_8}) + 4(\underbrace{\underset{\text{anorthite}}{CaAl_2Si_2O_8}}_{\text{plagioclase}}) + \underset{\text{orthoclase}}{KAlSi_3O_8} + 2\underset{\text{water}}{H_2O}$$

$$\begin{matrix} & & 402{\cdot}8 & 108{\cdot}3 & 36 \end{matrix}$$

$$= x(\underset{\text{albite}}{NaAlSi_3O_8}) + 2(\underset{\text{zoisite}}{HCa_2Al_3Si_3O_{13}})$$

$$\begin{matrix} & & & & & 275{\cdot}8 \end{matrix}$$

$$+ \underset{\text{muscovite}}{H_2KAl_3Si_3O_{12}} + 2\underset{\text{quartz}}{SiO_2}$$

$$\begin{matrix} & & & & & & 141{\cdot}1 & & & & & & 45{\cdot}6 \end{matrix}$$

The figures under the names of the mineral substances other than albite, which is unaltered, express their molecular volumes. It will be found that the total of these volumes under low pressure is 547·1, and under high pressure only 462·5.

When, therefore, plagioclase is subjected to sufficiently high temperature and pressure in the presence of a little water, and is decomposed in the manner described by Becke, the albite portion appears to go into temporary solution, and either recrystallises as water-clear albite *in situ*, or is the agent of the albitisation of neighbouring rocks, giving rise to the formation of spilites, spilosites, desmoisites, or adinoles. It is reasonable to suppose that the minerals which crystallise out from amorphous magmas under heavy pressure will be similar to those into which other minerals already crystallised are transformed under similar conditions of pressure and temperature.

It is, however, the garnets which are chiefly characteristic of rocks that crystallise under especially heavy pressure. Dr. L. L. Fermor [11] has described the occurrences of rocks in the Province of Vizagapatam (India), which appear to have been crystallised under such conditions.

These rocks are characterised by the presence of garnets which, under normal conditions of crystallisation, would have been replaced by anorthite, augite, diopside, hedenbergite (iron-diopside), wollastonite, olivine, tephrite (manganese-olivine), and magnetite. The garnetiferous rocks are calculated by Dr. Fermor to occupy 20 per cent. less space than their low-pressure equivalents. They contain orthoclase, although this, as we have seen, may be transformed under special conditions of pressure into muscovite and quartz, but they contain no soda-minerals. Presumably, under the conditions that prevailed, these would remain in the fluid state the longest, and only crystallise when the temperature had been lowered still more. Apparently they were pressed out in the fluid state from the Vizagapatam rocks, on a release of pressure, before this happened. These rocks appear to be made up of minerals which have crystallised out at great pressure below the under surface of the sial crust. Their crystallisation must have left a magma rich in soda and comparatively poor in the oxides of divalent minerals, such as lime, magnesia, and ferrous and manganous oxides.

We may expect a magma of this character to occur, either alone or in association with typical sima magma, in the molten magma arising from great depths in fissures formed in regions of tension. Such a magma

[1] Continued from p. 175.

[10] "Ueber Beziehungen zwischen Dynamometamorphose and Molekularvolumen," *Neues Jahrb.*, vol. 2 (1896), pp. 182-83.

[11] "Garnet as a Geological Barometer and an Infra-Plutonic Zone of the Earth's Crust," Rec. Geol. Surv., India, vol. 42 (1913), pp. 41-47.

is one that would give rise by differentiation to the series of alkali-rocks. These are characterised by low proportions of iron, lime, and magnesia, and an excess of potash, soda, and frequently alumina. In normal rocks the alkalies and lime of the felspars are accompanied by an equal molecular amount of alumina. The magnesia, the iron-oxides, and the remainder of the lime are also usually associated in many monoclinic pyroxenes and amphiboles with alumina. If a considerable proportion of the magnesia, iron-oxides, and lime be removed in the form of garnets, less than one-third of the equivalent proportion of alumina will go with them, so that it is not surprising that the percentage of alumina in the residue should be high, especially if, as appears frequently to happen, little or no zoisite or epidote is formed. In some instances, however, a certain number of the garnets formed at great depths are carried up with the alkaline magma.

The alkali rocks are sometimes found alone, as in the neighbourhood of Montreal and many localities on both sides of the Atlantic; but frequently they occur as occasional exceptions in a vast upflow and outpouring of normal rocks, mainly, but not exclusively, of basic composition. Examples of such modes of occurrence are met with in the Tertiary igneous rocks of the British Isles. Other examples of this association of normal and alkali-rocks occur in Scandinavia, India, and Australia.

Beyond the Eastern Atlantic deeps to which reference has been made lies the Central Atlantic bank, rising some 6500 feet (2000 metres) above the ocean-floor on either side of it. It only shows at the surface by virtue of local eruptions of volcanic rocks, mostly basic, but including occasional alkali-rocks, such as those of Rockall, which, however, is surrounded by a basaltic plateau close below the surface of the sea. The mass of the ridge must, however, consist of acid or sedimentary rocks, such as compose the continental masses. If it were not made up of such lighter rocks, it would not continue to exist. Whenever eruptions or earth-movements may, for the time being, disturb the isostatic equilibrium in any area, the forces of gravity acting on the yielding rocks of the earth's crust tend to restore it. Whatever may be the inequalities of the depth of the sea, they are compensated by the variation in the density of its bed. The only exceptions are minor irregularities so small that they can be maintained by the strength of the rocks, or so recent that the slow forces of readjustment have not had time to operate.

West of the central ridge is another ocean-deep formed in all probability by the same process of rifting, in the course of which the eastern margin of the North American continent drifted away to the westward. These Atlantic rifts represent far greater relative horizontal movements than those affecting western Europe, but they seem to be essentially similar in nature. The total displacement, towards the west, of eastern America relatively to western Europe would appear to vary from about 3000 miles (5000 km.) in the south of the North Atlantic to about 1400 miles (2300 km.) in the north. As Wegener claimed to be the case, the movement seems to have been largely in the nature of a rotation about a point in the far north. He thought, however, that the east of North America and the west of Europe were once actually in contact; whereas, according to my view, they were still separated in later Palæozoic times by an area, much narrower than the present Atlantic, which was sometimes wholly terrestrial and sometimes partly occupied by shallow mediterranean seas with a roughly north-and-south trend, one on the east and one on the west. They seem to have been to a great extent independent, for the marine faunas preserved in the later Palæozoic rocks of western Europe are strikingly different from the contemporary marine faunas in eastern North America, indicating the probable existence of a land-barrier between them. When, on the other hand, marine conditions were replaced by terrestrial, the similarity of the fossils and of the climatic evidences would seem to prove the existence of a continuous land-area.

When the rifting occurred, the rocks of the central land must have been fissured like those of Devon and Cornwall, and slipped away partly on one side and partly on the other, so that they no longer appeared above the sea, nor was the isostatic adjustment sufficient to raise them to the surface. The volcanic accumulations which form islands at various points on the central bank show a local excess of gravity. This indicates that their elevation is comparatively recent, so that isostatic adjustment is not yet complete. When it is, they may be wholly submerged, an event which would be hastened by subaerial and marine erosion.

A similar succession of events appears to have taken place in the South Atlantic. There the remarkable resemblance between the rocks on the opposite shores—ranging from the Devonian to the Jurassic—both in lithological characters and in fossil contents, seems to lead almost inevitably to the conclusion that they were once in much closer proximity, though probably not in actual contact, as supposed by Wegener, for there, too, is an important mid-oceanic ridge from which volcanic islands rise to the surface.

. . . . . .

Much of the structure of the African continent has yet to be determined; but, so far as it is known, it appears everywhere to support the view that there is evidence of the prevalence of tension directed outwards from the centre. This is in accordance with Wegener's contention that at the beginning of Mesozoic times there was a great "Ur-Kontinent," of which Africa was the centre, and that it has since been broken up by a relative movement of South America to the west, of west Antarctica to the south-west, of India to the north-east, of Australia to the east, and east Antarctica to the south-east.

Dr. R. Staub,[12] however, contends that, like India, Africa itself has moved northwards and given rise to the Eocene (Alpine) folding of Europe.

The question of the origin of regions of tension must now be considered. Why should they exist, or, to go one step further back, why should different portions of the continental masses tend to move apart from each other?

On the whole, the movement and the corresponding tension are roughly east and west, though frequently more or less diverted by local cricumstances. This prevalent direction naturally suggests that it is in some

[12] "Der Bau der Alpen," Berne, 1924, pp. 7-8.

way determined by the rotation of the earth, and is a result of tidal retarding action. Now, the rate of the retardation of the earth's rotation is known from astronomical evidence to be approximately an increase of 9 seconds in a century, per century,[13] and there seems reason to believe that this may all be accounted for by the friction of tidal currents in shallow seas (that in the oceans being negligible), so that it is apparently unnecessary to call in friction produced by the tides in the solid substance of the earth. It is claimed too that these tidal movements are so small —of the order of 1 metre, or 10^{-7} of the earth's linear dimensions—that the earth must be considered for this purpose as perfectly elastic, and that any purely elastic distortion of the earth can have no retarding effect.[14]

The first objection ignores the fact that, if there is a tidal deceleration, there is also an acceleration due to the secular contraction of the earth, which must, as I hope to show on another occasion, be considerable. Even the decrease in the ellipticity of the earth, itself due to a decrease in the velocity of its rotation, involves an acceleration which prevents that decrease from being so great as it otherwise would be. The retardation of the earth's rotation is therefore the difference between a decelerating and an accelerating effect, and these may be and probably are much greater than the difference between them. In other words, the deceleration, which is the measure of the effect of tidal friction on the earth, is equal to the retardation deduced from astronomical observations *plus* the acceleration due to the earth's contraction and change of form. Indeed it is possible that at an earlier period the acceleration may have been greater than the deceleration.

With regard to the second objection, I have recently shown[15] that the tidal distortion in the more superficial zones of the earth is much greater than in those at greater depths; and it would appear that in the former the ratio of the distortion to the total thickness of the zones would be of the order of 5×10^{-6}, fifty times as much as for the whole earth. Therefore the internal friction (the hysteresis, so to speak) in elastic distortion may not be negligible—especially as the outer crust is far from homogeneous, being subject to numerous forms of discontinuity, such as, on a small scale, the boundaries of crystals, sand-grains, pebbles, and fragments, besides planes of weakness in the crystals themselves, and, on a large scale, stratification, lamellation, foliation, cleavage, joints, faults, unconformities, and intrusions. Everywhere there are occasions of imperfection and inequality in mutual mechanical reactions, so that elastic distortion must frequently give rise to movements between surfaces in contact, with resulting friction and absorption of energy. In many cases forces tending to produce such a result are already acting, and only require a slight addition in order to overcome the resistance opposed to them.

[13] That is to say, the length of a day now is $9/(100 \times 365\frac{1}{4})$ of a second more than it was a century ago. It is usually assumed that this retardation affects the entire mass of the earth, whereas it is probable that the retardation of the earth's upper zones is slightly greater than that of the interior. If this be so, a correspondingly less amount of friction will be required to produce the observed result.

[14] H. Jeffreys, "The Earth," 1924, chap. iv. The effect of "elastic viscosity" (which involves permanent set or flow) is excluded where the periods of distortions are as short as those of the tides: for it is known to be inoperative with the Euler nutation, the period of which is considerably longer—fourteen months.

[15] NATURE, vol. 114 (1924), p. 749.

There seems, therefore, every reason to suppose that there are, even apart from the friction in shallow seas, forces tending to retard the rotation of the earth and especially of the outer zones, consisting mainly of crystallised igneous rocks and sediments, and thus to produce a movement of the exterior relatively to the interior from east to west.

These considerations unfortunately leave unexplained the divergent relative movement from Africa of the other constituent parts of the "Ur-Kontinent"—why the Antarctic continent should have drifted to the south or (alternatively) Africa to the north, or why America should have been retarded by tidal friction more than Europe-Africa, and Africa more than India and Australia.

There are, however, other possibilities that may explain the relative movement of portions of the earth's crust. According to Wegener, the sial, which in primeval times had covered the sima over the whole earth, had in the late Palæozoic era been restricted, so as to extend over little more than the fourth part; but it had become at the same time correspondingly thicker, as a result of the extensive folding that it had suffered. It then, as already stated, occupied a single area, of which what we now know as Africa was the centre, although there is evidence that some portions were covered by shallow seas, just as the present Mediterranean Sea now covers a part of the Old World continental area.

We have seen that since Hercynian times it has split up, different portions moving away in different directions. The evidence adduced by Wegener renders this at least a plausible hypothesis. He ascribes these changes to different rates of westward movement, and a drift away from the Poles; but a general drift from the centre of Africa to the centre of the Pacific seems to represent the real character of the movement more happily. Prof. H. Darwin explained such a movement by the hypothesis that the moon was, more than 50,000,000 years ago, thrown off from what is now the Pacific, and took with it much of the lighter surface-rocks, the sial in fact, which then occupied that part of the earth, and that the remainder has since been drifting towards the region of high density thus caused. If so, it would seem to have been held back by the resistance of the floor of the Pacific, and this has given rise to the circle of folded mountains which surrounds that ocean. Dr. H. Jeffreys,[16] however, believes that the earth gave birth to the moon when the young mother had herself only existed some 10,000 years, and that this must have occurred more than 1,000,000,000 years ago. He gives reasons for believing that the earth was then almost fluid, with at most a thin solid crust on the outside. This, in the violent agitation that took place during the process, must have been broken into fragments which would have forthwith spread themselves out in such a way as to become roughly distributed over the earth.[17] In any case, it would be inconceivable that the drifting towards the centre of the Pacific should have been delayed until nearly the end of the Palæozoic era. Of course, if the birth of the moon could have taken place in late Palæozoic times, when the earth's crust was already consolidated, and if it could have occurred, while

[16] "The Earth" (1924), chap. iii. p. 77.

[17] *Ibid.* p. 150, J. H. Jeans, Proc. Roy. Soc., vol. 93, A (1917), pp. 413-17.

allowing life to go on much as usual in other parts of the globe, there is no reason why the drift should not have taken place in Mesozoic and Kainozoic times; but, according to Jeffreys, the want of fluidity in the upper zones of the earth would then have rendered the separation impossible. Another objection to such an hypothesis is that there have been, during Palæozoic times and the long ages of the pre-Cambrian era, repeated occurrences on a large scale of mountain-building, folding, thrust- and slip-faults, and igneous intrusions and extrusions; so that there must have been repeated previous transformations similar to those that we can trace with greater distinctness in the immediate past. We cannot explain each of these by the birth of a satellite, for there is only one now existing.

There seems, however, to be a simpler hypothesis, which I will briefly indicate. The earth, as we know, contains a dense core surrounded by lighter material, the upper portion of which constitutes the sima. The sial is of course of comparatively insignificant thickness. It has been contended [18] that in the early history of the earth, when the resistance to compression and the rigidity were less, the heavy core was, on account of the earth's rotation, in a state of unstable equilibrium, and that, as a result, its centre of gravity probably does not now exactly coincide with that of the earth as a whole. Consequently, at that point on the equator to which the core is nearest gravitation is at a maximum. As, however, the attraction of the moon and sun results in friction which tends to retard the rotation of the earth's higher layers more than the interior, the former must have a slow movement relatively to the latter. We have seen that there is reason to suppose that in Palæozoic times the continental masses of sial were more or less concentrated round what is now Africa, forming the "Ur-Kontinent" of Wegener. This may well have been due to the fact that the maximum of gravity was then situated in that part of the earth. If then, during Mesozoic times, the movement of the higher layers of the earth had brought the centre of the Pacific into the position of maximum gravitation, the former great Palæozoic continent would tend to break up and drift apart towards the Pacific, and this is what appears to have actually happened. Similar changes may have occurred more than once in the earth's history since the remote time when the sial was spread over the whole globe.

It has been urged that the forces developed by the tidal action of the sun and moon, although large enough to cause a slow movement of the earth's crust as a whole, would not suffice to drive masses of sial through the sima, especially in the presence of the much larger compressive forces developed in the crust by the contraction of the earth's interior; still less to ruck up the earth's crust to form mountains tens of thousands of feet in height. It seems probable that this objection could also be urged against the adequacy for the same purposes of the forces developed by the variation of gravity from point to point on the globe, or against any combination of these two hypotheses.

To deal fully with this difficulty would involve the consideration of the principles of crustal compression and mountain-building, which I hope to discuss on another occasion. It will, I think, be at present sufficient to remark that, according to my view, it is precisely by the forces of compression that the crust has been folded and overthrust and the great mountain-chains raised up, but that the immediate result is the exhaustion, for the time being, of these forces and the simultaneous local destruction of the powers of resistance of the earth's crust, and that it is then and then only that the forces tending to cause the drifting of continental masses become free to act.

[18] J. H. Jeans, Phil. Trans. Roy. Soc., ser. A, vol. 201 (1903), p. 157; W. J. Sollas, Q.J.G.S., vol. 59 (1903), p. 180; A. E. H. Love, Phil. Trans. Roy. Soc., ser. A, vol. 207 (1908), p. 171; and NATURE, vol. 76 (1907), p. 327.

Obituary.

DR. F. E. BEDDARD, F.R.S.

ZOOLOGY has lost a distinguished and devoted servant in the death of Frank Evers Beddard, which occurred at his home at Hampstead on July 14. He will be remembered best, perhaps, as the prosector of the Zoological Society: a post which he held for more than thirty years. He succeeded to great traditions, and worthily upheld them during his long term of office. Those who were privileged to listen to his discourses, at the scientific meetings of the Society, will ever remember his extraordinary facility of expression and the clear and rapid way in which he laid abstruse points before his audience. Few, probably, who were listening had ever made the dissections he was describing, yet so admirable was his presentation of the facts he had gleaned, that they could not fail to grasp the essential points laid before them. He had no rival in this regard.

Beddard's work on vertebrate anatomy covered a wide field, and though it may have been marked by no epoch-making discoveries, it maintained a high level of excellence. He has left, in the pages of the Proceedings of the Zoological Society, a rich storehouse of information for future investigators. His contributions to science, in the form of original work, were, however, by no means confined to the vertebrates. He wrote a memoir on the Isopod Crustacea collected by the *Challenger* Expedition; and a fine monograph on the Oligochæta, issued by the Clarendon Press. This was, perhaps, his favourite group, and embraces some of his best work.

In his books Beddard did himself less than justice. His volume on whales, for example, was good, but he could have given us a much better book. The same may be said of his volume on the classification of birds, and that on the coloration of animals. In these he seems to have shirked the labour of coming to a decision on the very vexed and controversial points which these two themes presented. He nowhere commits himself to a definite opinion as to whether he does or does not agree with the conclusions arrived at by others, whose views he sets forth without comment. His pages are almost too dispassionate to be helpful.

Beddard was elected a fellow of the Royal Society in 1892, and was the recipient of the Gold Medal of the

Linnean Society. For some years he was lecturer on biology at Guy's Hospital, and he also acted in the capacity of examiner in morphology at Oxford, and in zoology and comparative anatomy in the University of London. Finally, he was a man of great personal charm, who was always willing to put his wide knowledge and experience as a zoologist at the service of others.

W. P. P.

WHILE many can speak of Dr. F. E. Beddard's zoological work in general, there must be few who knew his special work on the Oligochæta so well as myself. For upwards of a quarter of a century we were in constant correspondence, exchanging papers, specimens or notes. It is forty years since he began to publish on the subject of annelids. Alongside of his professional work he had already spent at least ten years on the oligochæts before his *magnum opus* was issued by the Clarendon Press ("A Monograph of the Order Oligochæta," 1895). In the bibliography appended to this work no fewer than eighty-five items are recorded as his own, while Benham and Friend are each credited with twenty. Beddard did not profess to pay special attention to the British annelids, and very few of the species described in his monograph have indications that they may be found in Great Britain. His own material came from every part of the globe, but the tropical worms were perhaps those he knew best. What he did for Asia in particular largely paved the way for the splendid work which Stephenson has done and is still doing. When I took up the work in 1890, Beddard, together with Dr. Benham, gave me every possible help; and as my work on British annelids, and particularly that on the Enchytræids, grew, he regarded that department as mine, and left me an open field. He was ever ready to recognise the work of others, and never looked askance at one who worked as an amateur in the provinces with all the odds against him.

In 1912 Beddard issued a little volume on "Earthworms and their Allies," but his output was so enormous that he had no time for cultivating a fine literary style. If he has left behind little, however, that would make worms popular with the general public, his monographs and memoirs will always remain as a tribute to his industry, and as a mine of wealth for the specialist. He will long be remembered as England's foremost authority on the Oligochæta.

HILDERIC FRIEND.

DR. S. T. DARLING.

AN eloquent appreciation, from the pen of Prof. R. W. Hegner, of the life and work of Dr. Samuel Taylor Darling, of the League of Nations Malaria Commission, appears in a recent issue of *Science*. Dr. Darling, it will be remembered, was killed, with two other members of the Commission, on May 20 in a motor-car accident near Beirut in Syria. He is described by Prof. Hegner as "one of the foremost American students of tropical medicine, especially in the field of medical zoology."

Dr. Darling was born in 1872 and chose medicine as his career. In 1903 he went to the Ancon Hospital in the Panama Canal Zone and three years later he was appointed chief of the laboratories of the Isthmian Canal Commission, a post which he held until 1915. During this time he took up the study of parasitic organisms causing diseases in man and animals and of malaria, and published some noteworthy papers on histoplasmosis, sarcosporidia, the malarial organism and its mosquito vectors, trypanosomiasis in horses, leishmaniasis, endamœbæ, and similar subjects. In 1913–1914, Dr. Darling accompanied General Gorgas on a sanitary mission to the Rand mines and Rhodesia and in 1915 he joined the staff of the International Health Board of the Rockefeller Foundation. As head of a medical mission of the Board he spent two years studying the causes of anæmia among the peoples of Malaya, Java, and Fiji. Some of the results of this mission appeared in a report, of which Dr. Darling was part author, on "Hookworm and Malaria Research in Malaya, Java, and the Fiji Islands." He was then sent to Sao Paulo, Brazil, where he established a laboratory for teaching and investigation on these subjects, and in 1922, when the International Health Board decided to found a field laboratory for the study of malaria at Leesburg, Georgia, Dr. Darling was chosen as the first director. Here, according to Prof. Hegner, he did some of his best work as an investigator and as a teacher, training men who were afterwards sent out on malaria control campaigns.

Dr. Darling was an honorary fellow of the Royal Society of Tropical Medicine and Hygiene, president in 1924–25 of the American Society of Tropical Medicine, a member of many other American and foreign learned societies, and of the National Malaria Committee. His widow has presented his library to the Department of Medical Zoology of the School of Hygiene and Public Health, Johns Hopkins University, Baltimore, and it will be known as the Samuel Taylor Darling Library.

WE regret to announce the following deaths:

Dr. Charles W. Burrows, formerly head of the magnetic section of the U.S. Bureau of Standard, who was distinguished for his work on magnetic testing and on the magnetic properties of alloys of iron, on May 2, aged fifty years.

Dr. David T. Day, for twenty years head of the department of mining and mineral resources of the U.S. Geological Survey, who made a special study of the constitution of petroleum and its derivatives, on April 16, aged sixty-five years.

Prof. Louis Gentil, professor of physical geography at the Sorbonne, Paris, and member of the Paris Academy of Sciences, distinguished for his exploration work in Morocco and other parts of northern Africa, on June 12, aged fifty-six years.

Dr. J. Guillarmood, a distinguished Swiss geographer and explorer and the author of several works on the Himalaya, on June 6, aged fifty-seven years.

Dr. I. Minis Hays, secretary general of the International Medical Congress held at Philadelphia in 1876, and secretary since 1897 of the American Philosophical Society, on June 6, aged seventy-seven years.

Prof. F. R. Japp, F.R.S., emeritus professor of chemistry in the University of Aberdeen, on August 1, aged seventy-seven years.

Dr. E. J. McWeeney, professor of pathology and bacteriology in University College, Dublin (National University of Ireland), and bacteriologist to the Local Government Board, on June 20, aged sixty-one years.

Current Topics and Events.

THE German Chemical Society has recently published a "warning" directing attention to the very large numbers of young chemists now coming from the universities, many of whom are unable to find suitable employment. Figures are given showing the extraordinary increase in graduates from the chemical faculty, as compared with those from other departments of the universities. It is anticipated that the number of chemical graduates this year will be about 1100, whereas it is computed that German industry is only able to absorb about one-third of that number, that is to say, about 350 per annum. Opportunities abroad for German chemists are now considerably less than they were before the War, partly for political or sentimental reasons, and partly because of the growing tendency in most countries having industrial aspirations to develop their chemical industry by employing their own chemists to the almost total exclusion of the foreigner.

THE "warning" referred to above has aroused considerable discussion in the German technical press. One of the main points brought out in this discussion is that German industry, as a whole, does not avail itself of the help of chemical science nearly so much as it should do; and there are many important branches of industry which might profit from a greater appreciation of applied chemistry, but the chemist is almost wholly ignored or is given a quite subordinate status. This may sound a little strange, for the view has hitherto been prevalent in Great Britain that at least in Germany the chemist was fully appreciated. Be this as it may, another point emerging from the discussion in the press is that it is not altogether the fault of industry if the chemist is somewhat neglected in some branches of manufacture. It is urged that his training is often at fault: it is too academic. Others consider that the main difficulty is that too many leave the universities without troubling to take their degrees. However, the warning does not so much apply to these as to the men who take high places in chemistry, and are yet unable to find employment. It may be that many of them, in view of their supposed qualifications, want too high salaries to begin with, and German industry in its present rather poverty-stricken condition cannot afford high outlay on scientific research. As in Great Britain, the mistaken policy is often adopted of starting any retrenchment in the research department.

TWENTY-FIVE years ago, in Lahore, the Society for Promoting Scientific Knowledge was started by medical college students, supported later by professors and local medical practitioners, to do something towards educating the public in matters scientific, and in particular in matters of public health, sanitation and household hygiene. It was no light task when all but the promoters appeared apathetic; by steady persistence, however, recognition and popularity followed; by local subscriptions and a grant from the Punjab Government, the S.P.S.K. became firmly established, with its own large public lecture hall. Branch societies were opened at various places in the Punjab and even in Kashmir. By the publication of a magazine and many leaflets in the vernacular, numerous public lectures and conversaziones, the Society does good work; the Society's functions are well attended by all classes with undoubted beneficial results. The future of the Society is full of promise, for it has enlisted the support of the most prominent government officers and citizens, with His Excellency the Governor of the Punjab as patron. The Society's silver jubilee was celebrated by a conversazione in the Chemical Laboratory of the University of Lahore and the Biological Laboratories of the Government College and a public meeting in the Society's Hall.

AT the recent conversazione of the Royal Society, exhibits of several types of steel containing nickel and chromium and offering a high resistance to corrosion were exhibited. The specimens shown by Sir Robert Hadfield included two new alloy steels which are notable for their permanence on exposure to the atmosphere and to fresh or salt waters, differing from the ordinary non-rusting chromium steels in being independent of heat treatment. The heating and cooling curves indicate a complete absence of critical points, and no change of phase is detected by microscopical examination, so that the structure remains homogeneous whatever be the heat treatment to which the steel is subjected. Riveting and brazing consequently have no effect on the capacity of the alloy for withstanding corrosion. The exhibit included turbine blades and test specimens showing the mechanical properties of the steel at atmospheric temperatures and at temperatures up to 650° C. under prolonged loading, showing the absence of creep. Specimens were also arranged to illustrate the history of the attempts to improve the resistance of iron and steel to corrosion, rusting and scaling.

PROF. RAYMOND PEARL has endeavoured to estimate statistically the relation, if any, between the number of doctors per unit of population and the death rates observed for the same population (Journ. Amer. Med. Assoc., 1925, vol. 84, p. 1024). It appears that for the thirty-four States of the United States investigated, there is no significant difference in the mortality rate of a community in 1920, whether that community had few or many doctors per unit of population. Two morals suggest themselves from this result. The first is that perhaps the chief social and human value of the physician is in alleviating suffering, rather than in preventing death, at which last task he must in every case ultimately fail. The second is that while there is a great difference between good doctors and poor doctors in respect of the result of their activities, there is no significant difference between a good doctor and no doctor at all!

WE learn from *Science* that the new building and laboratories of the Marine Biological Laboratory, Woods Hole, Massachusetts, were opened on July 3.

Mr. C. R. Crane, president of the board of trustees, made himself responsible for the cost of the new building beyond the original estimate of 100,000*l.* In all, a sum of 280,000*l.*, including gifts from the Rockefeller Foundation, the Carnegie Corporation, Mr. John D. Rockefeller, Jr., and the Friendship Fund, was collected, and 180,000*l.* of this has been invested for endowment. Previous to this extension, the assets of the Laboratory were valued at 100,000*l.*, so that the trustees now have a property worth nearly 400,000*l.* to administer. The new building provides for an extension of the library, a lecture hall, offices, research rooms supplied with fresh and salt water for aquaria, photographic rooms, and so on.

THE report of the Valletta Museum for 1923–24 is largely taken up with accounts of excavations on prehistoric, Phœnician, and Roman sites. Two finds are particularly noteworthy. Neolithic debris at Hagiar Kim yielded a statuette in baked clay, consisting of the head and neck of a figure with horns coiled twice round the ears. The figure may be that of a ram, but is believed to be more probably human; it is 43 mm. high. At Mgar, where are, or were, extensive megalithic ruins, was found a model of a megalithic building, made of globigerina limestone. The model, which is 47 mm. long and 33 mm. high, represents an oval building of slabs on end with pillars between them, and roofed by eight horizontal slabs. The entrance is through a trilithon with a high sill.

OF the making of journals there is no end. The increase in the number of biological journals since the War has been surprising, yet they nearly all appear to fill a useful place in the development of science. The latest addition is called the *Archiv für experimentelle Zellforschung besonders Gewebezuchtung* (*Explantation*), and aims at covering the field of tissue-culture, microdissection and similar experimental work with the cell. The general editor is Prof. Rhoda Erdmann, of Berlin, and she is assisted by fourteen investigators in various countries, whose names are connected with these fields of research. Papers are accepted in English, German, French, and Italian. The first number, which we have recently received, begins with an extended Italian paper by G. Levi on the conservation and loss of independence of tissue cells in culture. Other papers deal with cultures of heart tissues and sarcoma cells. M. Thielman describes culture experiments with stomatal plant cells, and Albert Fischer describes an apparatus for extracting the juice from parenchyma tissues. The number concludes with a list of the papers which have appeared in this field in the years 1920–1924, compiled by the editor, and covering thirteen pages. It is intended later to compile all the literature from the beginning of tissue culture. Any authors whose papers are not included in this list are asked to send the titles to the editor at Nassauische Strasse 17II, Berlin-Wilmersdorf. This number of the journal contains 144 pages and one coloured plate. It is published by Gustav Fischer, Jena, and the price is 8 gold marks.

THE autumn meeting of the Iron and Steel Institute will be held at the University, Birmingham, on September 9-11, under the presidency of Sir Frederick Mills, Bart. The programme includes papers on blast-furnace practice in India, high-frequency induction furnaces, properties of single iron crystals, moulding sands, and on various iron and steel equilibrium systems. Cheap travelling facilities are being granted by the railway companies.

THE Royal English Arboricultural Society has arranged for a number of visits to forests in different parts of England and Wales during the month of August. The visits are open to all who are interested in forests and woodlands. The summer meeting of the Society is being held at Norwich during the first week of September. Particulars can be obtained from the secretary, Mr. E. Davidson, Estate Office, Haydon Bridge, Northumberland.

THE Minister of Health has appointed the following committee "to draw up a practicable scheme of post-graduate medical education centred in London": —The Minister of Health (chairman), Sir Arthur Robinson, Lord Dawson of Penn, Sir Humphry Rolleston, Bt., Sir John Bland-Sutton, Bt., Sir Thomas Horder, Bt., Sir George Newman, Sir George Blacker, Dr. R. A. Bolam, Dr. H. G. Dain, Mr. H. J. Paterson, Dr. J. Parkinson, Dr. H. L. Eason, Prof. Hugh Maclean, Mr. A. E. Webb-Johnson.

AT a meeting of the Vienna Academy of Sciences on June 12, Dr. Oswald Redlich was re-elected president, and Dr. Richard Wettstein vice-president. Dr. William Exner of Vienna and Dr. Waldemar Chr. Brögger of Oslo were made honorary members. Dr. Niels Bohr of Copenhagen, Dr. Max von Laue of Berlin, and Dr. Eugen Korschelt of Marburg have been elected foreign corresponding members. The following awards were made: the Lieben prize to Dr. L. Meitner for publications in the *Zeitschrift für Physik* on β and γ rays of radioactive substances; the Haitinger prize to Dr. R. Kremann for work on the electrolysis of metal alloys, and also to Dr. L. Moser for work on quantitative analysis and the purification of gases. The prize of 1000 golden krones for a work on the physiology and pathology of the effect of high altitudes offered by the Semmering Alpine Sanatorium, Austria, has not been awarded, but is offered again. The prize is intended for Austrians, but foreigners will be considered if their work is done in Austria. Papers should be sent to the Kanzlei of the Akademie der Wissenschaften, Wien I., Universitätsplatz 2, before December 31 of this year.

THE Smithsonian Institution at Washington has just issued its annual Exploration Pamphlet (Smithsonian Miscellaneous Collections, vol. 77, No. 2), of which rather more than half is devoted to archæological and ethnographical investigations in the field during the past year. An expedition to China sent out under the joint auspices of the Freer Gallery of Art of the Smithsonian, and the Museum of Fine Arts, Boston, carried out successful investigations at I Chow, in the province of Chihli, and at several

localities in the province of Shensi. In these regions the sites of two ancient cities were traced and many mounds inspected. The first actual excavating was done at Yu-ho Chen, in the province of Honan, where two tombs of the Han Dynasty (206 B.C. to A.D. 221) were opened. Cultural objects from prehistoric times to the Han period were brought to light, including chariot-fittings, mirrors and arrow-points of bronze; one or two gold rings; much pottery, and many other interesting objects. In Florida Dr. J. Walter Fewkes excavated the large Weeden Mound, and brought to light a large collection of Indian skeletons, pottery, artifacts, and other material of prehistoric origin. This mound was found to consist of two distinct layers; a lower layer containing crude, undecorated pottery, and an upper layer which produced decorated pottery, each piece of which was "killed," or punctured to allow the escape of the spirit of the bowl. In Alabama he uncovered several interesting mounds, including one which would shortly have been submerged by the back water from the Wilson Dam at Muscle Shoals.

ONE of the principal features of the celebration at Amsterdam on October 25, 1924, of the jubilee of the foundation of stereochemistry by Le Bel and van 't Hoff, was the delivery of a masterly review by Prof. Walden of Rostock (formerly of Riga) of the progress of stereochemistry during the intervening fifty years. This review was printed in the Amsterdam *Chemisch Weekblad* of January 24, 1925, but has been appearing in a revised form in *Die Naturwissenschaften* (April 10-May 1). This revision has made it possible to include references to the literature published up to the end of 1924. The review is therefore as noteworthy for its completeness as for the masterly way in which the vast range of material has been marshalled into a well-ordered scheme.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned: Two or three assistant superintendents in the Geological Survey of India—The Secretary to the High Commissioner for India, 42 Grosvenor Gardens, London, S.W. 1 (August 15). A research officer in crop and animal husbandry under the Ministry of Agriculture for Northern Ireland—The Secretary to the Ministry, Wellington Place, Belfast (August 17). An assistant in the Pathological Laboratory, Harpenden, of the Ministry of Agriculture and Fisheries—The Secretary to the Ministry, 10 Whitehall Place, London, S.W. 1 (August 29). An assistant at the National Physical Laboratory to act as librarian and editor of publications—The Director, National Physical Laboratory, Teddington (August 31). An assistant in the department of natural history and zoology of the University of Edinburgh — The Secretary of the University (September 25).

Our Astronomical Column.

THE COMPANION OF SIRIUS. — Prof. Eddington announced, at a recent lecture to the Cambridge Philosophical Society and the members of the International Astronomical Union, an interesting result arrived at by Dr. C. E. St. John at Mount Wilson Observatory. It has been found possible to photograph with the 100-inch reflector the spectrum of the companion of Sirius separately from that of the bright star. It is of type F and therefore its surface brightness is greater than that of the sun; from its very feeble luminosity its diameter is concluded to be about that of the planet Uranus, while its mass is three-quarters of that of the sun. Hence its density is enormously great, and it is a favourable object for Einstein's third astronomical test—that of the spectral shift. Single stars do not avail for determining this, since we cannot separate radial velocity from Einstein shift. But in this case, differential measures from Sirius are possible, the correction for orbital motion being well known.

The result is very striking; after allowing for orbital motion, an Einstein shift equivalent to a radial motion of 21 km./sec. was found. This was tested on a large number of lines, so that it appears to be well established. The result is very important in two ways. First, it gives a confirmation of the Einstein spectral shift stronger than we can obtain from the sun, where its value is only 0·6 km./sec., an amount that it is difficult to separate from pressure effects or systematic surface drifts. Secondly, it affords strong evidence of the truth of Prof. Eddington's conclusion, arrived at last year, that atoms when stripped of their outer electrons are capable of being packed to extraordinary density without departure from the gaseous state; the density deduced in this case is hundreds of times that of the metals. Details of the investigation will be awaited with interest, but the well-known skill of Dr. St. John justifies us in receiving it with considerable confidence.

AN INDIAN ASTROLABE.—In the *Heidelberger Akten der von-Portheim-Stiftung* (No. 13) (Heidelberg: Carl Winters Universitäts Buchhandlung, 1925, 4 gold marks) Dr. Josef Frank and Dr. Max Meyerhof have published a paper, "Ein Astrolab aus dem Indischen Mogulreiche," which gives a lengthy description of an astrolabe in the Kestner Museum at Hanover. In a bibliographical introduction, the authors give a list of four manuscripts and many printed memoirs on astrolabes consulted by them, not including those quoted in the course of the paper. Next follows a description of the instrument, which is of medium size, having a diameter of 84 mm., and a short account is given of the various problems of spherical astronomy and astrology to which the instrument can supply approximate solutions. For this purpose every planispherical astrolabe is furnished with a number of circular plates which fit in the rim of the "mother" or shallow circular trough on the front of the instrument. On these plates are engraved for various latitudes stereographic projections of the principal circles of the celestial sphere. The instrument in question has plates for the latitudes 18°, 21° 40′ (Mecca), 24°, 27°, 32°, 35°, 39° 37′, the last one being probably for use at Bokhara. An inscription on the triangular bracket carrying the ring, whereby the instrument is suspended, shows that it was made in A.H. 1018 (A.D. 1609) at Lahore by two brothers, sons of Isa b. Allahdad, and belonging to a family of astrolabe makers. Other inscriptions, mostly in Persian, give 37 names of towns (with longitudes and latitudes), chiefly in the Mogul Empire; but it is not unlikely that these inscriptions are due, not to the maker, but to a somewhat later owner.

Research Items.

RELIGIOUS BELIEFS IN THE SIMLA HILLS.—Mr. H. A. Rose has communicated to the June and July issues of the *Indian Antiquary* a number of legends of the *deotas* or godlings of the Simla Hills, collected mostly from the district of Khumhârsain by Pandit Sukh Chain. The legends cover seven families or groups, and in most cases give an account of the origin of the godling and its cult. In a number the serpent appears. Koṭ Ishwar, for example, who originated in the temple of Durga at Haṭ Koṭī and had been imprisoned by the magic of the Brahmans on account of his oppression of the people, in order that he might be thrown into the river, escaped and troubled the people in the form of a serpent, sucking milk from the cows. The same story of taking the milk from the cows in the form of a serpent is told of the *deota* Marech of Malindi. Kalû, the eldest of five brothers and a hermit, when he died became a snake living on Tikkar Hill who devoured men. He could draw people into his mouth from afar by his breath. Others of the godlings had a fondness for human flesh, and demanded human sacrifice. Dithû's favourite meal was a woman's breast, of which he ate one every day. He was arrested on the order of Koṭ Ishwar, and not released until he had sworn not to touch human flesh again.

SCULPTURED STONES FROM GORGONA, SOUTH AMERICA.—In *Man* for July, Mr. Hornell continues his account of the archaic sculptured rocks found on the island of Gorgona by the *St. George* Expedition. On a second group of rocks the incised figures were very numerous, but greatly worn. The central boulder of the group is thickly set with small cups from an inch to an inch and a half in diameter, and half an inch in depth. At the ends are the figures of a frog and a bird, and on one side is a triangular axe lashed to a haft. On a ridged stone near by is a rude human face and a complicated, but symmetric, design of superimposed groovings. These designs appear to have been cut with stone implements, and a number of such implements have been found together with fragments of pottery. Embedded in the beach were numerous fragments of large stone troughs. One of four boulders with relatively modern engravings showed a head with a peculiar form of tailed cap which points to an Indian, possibly Inca, origin. Later investigations, on a second visit, suggest that the stones described in the previous communication were the sacred place of the island, while the second is probably secular. Two settlement sites were dug and showed that the inhabitants probably lived in pile-dwellings.

GEOLOGY OF THE TAUNGS STRATA.—It will be remembered that the limestone block from which Prof. R. Dart chiselled out the fossil skull of *Australopithecus africanus* was brought to him by his colleague, Dr. R. B. Young, professor of geology in the University of the Witwatersrand, Johannesburg. On April 20 last Dr. Young read a paper to the Geological Society of South Africa on the cliff-limestone at Buxton, seven miles to the south-west of Taungs, from which the famous fossil was quarried in November 1924. From this paper (Trans. Geol. Soc. S. Africa, 1925, vol. 28, pp. 55-67) we learn that the cliff-limestone at Buxton was deposited at the eastern edge of the Kaap plateau by streams and springs issuing from the dolomitic limestone of that plateau. Dr. Young found that calcareous deposits were still being formed at various points along the eastern escarpment, and although he refuses to hazard an opinion as to the geological age of the cliff-limestone exposed in the quarry at Buxton, it is clear that he does not think it can be older than the pliocene and may be later. In this recent limestone deposit numerous and extensive caves and passages formed, many of them communicating by fissures with the surface of the plateau. The caves, when exposed on the face of the quarry at Buxton, were found to be filled by bedded sands, similar in texture to those of the Kalahari. Dr. Young sums up his opinion regarding the antiquity of Australopithecus in a concluding paragraph thus: "This conclusion applies to the skull of Australopithecus. The position in the quarry face from which it came . . . was a few feet to the left of the body of loose sand already described in detail. The limestone in which it was embedded was full of reddish sand and, as previously shown, probably formed part of the filling of an underground passage in the limestone. The loose sand had all the appearance of being water deposited, and possibly the skull was washed in from the surface. I may mention that the latter event seemed to me the more probable when, above the limestone cliff at Thoming, I came on an isolated, complete, and partly cleaned skull of a baboon which had obviously been removed along by surface water and might easily be washed into any opening in the rock." Dr. Young also found that baboons still frequent caves along the eastern escarpment of the Kaap plateau.

THE LAVALA WEED IN INDIA.—The Lavala weed, *Cyperus rotundus*, probably reduces the crop yield in many fertile districts in India by 25 to 30 per cent., and in view of the great loss thus incurred S. B. Ranade (Mem. Dept. Agric., India, 13, No. 5) has fully investigated the life history of the plant with the view of ascertaining its most vulnerable points and the best means of effective eradication. Enormous quantities of "seeds" (calculated at fifty-four million per acre) are produced throughout the year, particularly in July and October, and prevention of flowering is therefore of paramount importance. Lavala is of geophilous habit, and establishes a subterranean tuber system as soon as the first aerial shoots have appeared, but not before. Consequently, if germinating seeds or tubers can be prevented from putting up aerial shoots, by means of judicious cultivation and weeding, it is possible to prevent fresh colonies from being formed. Established colonies in badly infested land penetrate three feet deep in the soil, and though repeated removal of the aerial parts at short intervals will eventually exhaust the tubers, the process is very slow. Experiments indicate the value of bringing the tubers to the surface by deep ploughing, as tubers exposed on the surface of the soil in hot weather, or not deeper than three inches deep in dry soil, are killed in eight days. The use of certain smother crops is also successful, sann hemp distinctly reducing the numbers of tubers in the soil, though other methods of covering were less useful. The best practical method of treatment seems to be continuous hot weather cultivation, in order to expose as many tubers as possible to the air, followed by a thick green manure crop ploughed in early, and again succeeded by a second dry season's continuous cultivation. Once clear, no difficulty should be experienced in keeping the land clean from further infection. The article includes details of many laboratory experiments yielding much information with regard to the propagation of Cyperus by tubers and on the effect of spraying with various chemicals.

HYDROGEN-ION CONCENTRATION AND CELL DIFFERENTIATION IN PLANTS.—Dr. H. Pfeiffer of Bremen pub-

lishes a long and very interesting paper (in German) in vol. 24, No. 2, of the *New Phytologist*, in which he records his observations upon the relation between the P_H of the developing tissue and the process of differentiation; his data being obtained from studies of the secondary phloem of the dicotyledon. He has studied the crystallisation of calcium oxalate from solutions of different P_H and points out that the monoclinic crystals (raphides) are deposited at low (acid) P_H values, whilst the tetragonal (sphæraphides) or amorphous forms are deposited from neutral or alkaline solutions. Pfeiffer then employs indicators upon plant sections, and concludes that this factor of P_H is probably of importance in determining the form of the crystalline deposit laid down in the living cells of the secondary phloem and cortex. Dr. Pfeiffer further shows that thin-walled cells appear to be associated with a low P_H of the tissue during development, whilst in tissues that are more alkaline during development thick cellulose deposits are the rule.

INDIAN AMPULLARIIDÆ.—In 1920 the Zoological Survey of India, then under the Directorship of the late Dr. T. N. Annandale, began a series of small monographs on the genera of the freshwater gastropod Mollusca of the Indian Empire as a basis for the accurate determination of those species, if any, that acted as the intermediate hosts of internal parasites inimical to man. The latest, and in some respects best, of these is a "Revision of the Indian Ampullariidæ," by Dr. B. Prashad (Mem. Indian Mus., 8, No. 2). The author, who accepts Dall's classification for the family published in 1904, recognises two genera as being present in India—Pila of Bolten, to which belong the common forms found in the plains, and Turbinicola of Annandale and Prashad, embracing the hill-stream species. Nine species of the former, including *P. robsoni*, n.sp., and two of the latter are carefully and adequately described almost entirely from the conchological aspect, and for the first time in the series a properly worked out synonymy is prefixed to each, thus greatly enhancing the value of the work. The three plates of shells prepared from untouched photographs by the artists of the Survey well deserve the commendation bestowed upon them by the author.

GEOCHEMICAL DATA.—Those interested in the study of rocks and minerals, more especially in relation to geochemical processes, will welcome the recently published fifth edition of Dr. F. W. Clarke's "Data of Geochemistry" (Bull. 770, U.S. Geol. Surv., 1924). The first edition of this very useful bulletin was published in 1908, being followed by later editions in 1911, 1916, and 1920. The work has been revised for the present edition, which, with its 841 pages, has ten more than the previous one. The author does not pretend that the book is an exhaustive monograph on geochemistry. He modestly claims that it presents to the reader a critical summary of what is now known about this subject, and serves as a guide to the more important literature. He gives little attention to merely speculative matters, preferring, in accordance with the title of the book, to set out the available data. These relate not only to rocks and rock-minerals, but also to coal, petroleum, and metallic ores. Chapters are given to the chemical elements, the atmosphere, lake and river waters, ocean waters, well and spring waters, saline residues, volcanic gases and magmas. The book is a model of accuracy and terseness. Probably none of the other publications of the United States Geological Survey has attained such a wide and well-deserved popularity among students of chemical mineralogy and geology. It is already so well known that it seems almost superfluous to recommend it to any one interested in the data of geochemistry.

THE ORIGIN OF THE RYDBERG SERIES.—In *Die Naturwissenschaften* of July 3, Prof. A. Landé of Tübingen raises the question, "Why do the chemical elements fall into periods of 2, 8, 8, 18, 18, 32?" A novel answer is given to this question, since by taking into account the four series of quantum numbers (n, K, J, m) indicated by the analysis of spectra, it appears that the total number of options is 2, 8, 18 and 32 for the cases in which $n = 1$, 2, 3 and 4. There is therefore only one electron for each option, and no two electrons need be assigned the same series of four quantum-numbers, even in the case of the more complex atoms. This classification of orbits is, however, different from that which was in vogue a year or two earlier, and depends on assigning to K the quantum numbers $\frac{1}{2}$, $\frac{3}{2}$, $\frac{5}{2}$, etc., instead of the integers which were used at an earlier stage.

MONOMOLECULAR FILMS ON WATER.—A paper on this subject, by W. D. Harkins and E. H. Grafton, appears in the May issue of the Journal of the American Chemical Society. The areas occupied in films by the molecules of various hydroxy-derivatives of benzene were determined by surface tension measurements of their solutions. The results indicate that while phenol, pyrocatechol, resorcinol and pyrogallol give "condensed" films (*i.e.* films of low compressibility), these films are nevertheless not "closely packed." All the substances investigated give expanded or "gaseous" films at lower concentrations of the solutions. It is probable that the hydroxyl group turns towards the water, while the phenyl group is on edge or on end above it. With *o*-hydroquinol, however, both hydroxyl groups are immersed in the water, while the phenylene group remains on the surface.

TESTING RADIO-TRANSMITTING ANTENNÆ.—A serious difficulty in connexion with experimental research on the best shape of the antennæ used in radio communication is that in practice the radiating systems used are very elaborate and costly. Once these systems are erected their heavy initial cost makes it imperative that they be operated commercially as soon as possible, and very little time is available for scientific investigations. The research bulletin issued last May by the University of Illinois dealing with the question as to whether the action of antennæ can be investigated by means of models is therefore a timely one. The author, Mr. J. Tykociner, adopts two theorems proved by Max Abraham about thirty years ago. They are that if we have two geometrically similar oscillators, their natural periods are proportional to the lengths of their respective segments, and they also have equal logarithmic decrements. The assumption is made that the ohmic resistance of the conductors is zero; the decrement is supposed to be due, therefore, to the radiation resistance. A proof is given that the radiation resistance of a model antenna is approximately equal to that of the original antenna. The smaller the model, therefore, the higher becomes its fundamental frequency as compared with that of the real antenna. Full instructions are given for making model antennæ. It is shown that the working characteristics of full-sized antennæ can be predicted with a maximum inaccuracy of about one per cent. by this method. Exceedingly short waves are used in the experiments, their wavelengths being less than 10 metres. They do not disturb, therefore, commercial radio traffic, and the errors due to the interference of commercial radio stations are negligibly small.

Filter-passing Viruses in Disease.

AT the Bath meeting of the British Medical Association a discussion on the filter-passing viruses occupied the first day of the meeting of the Section of Pathology and Bacteriology. The discussion was opened by Dr. W. E. Gye. Dr. Gye criticised the expression "filter-passing viruses," which is generally used to include certain viruses which have hitherto not been proved to be filterable. The use of the term "filterable viruses," though convenient, has at present no real significance. His own experience has been particularly with Rous's chicken sarcoma, and even with this virus, filtration can only be conducted if certain experimental conditions are observed. If the tumour emulsion be insufficiently diluted, and if distilled water be employed instead of saline, the filtration is much more difficult, and it is seldom that an infective filtrate is obtained. By using a small volume of saline, or by using distilled water as a diluent, one obtains a viscous solution of mucin and nucleo-protein which will not pass the filter readily. The hydrogen ion concentration of the liquid also affects the rate of filtration; within limits not yet exactly determined, acidity increases the difficulty of filtration and alkalinity makes the process easier. The properties of the liquid in which the virus is suspended thus play an important part in the results of filtration.

A further important factor in filtration is the adsorptive capacity of the filter. Under certain conditions the filtrates of the infective material in Rous's sarcoma failed owing to the adsorption of the virus on the surfaces of the filter. The only method readily available by which the particulate character of viruses can be tested is that provided by the centrifuge. In the case of Rous's sarcoma, long centrifugalisation, at 8000 revolutions a minute at least, is necessary to obtain a definite difference in the infective actions of the upper and the lower layers. There is an urgent need for a machine which will spin at a higher speed with safety and is so constructed that fluids can be spun without running the risk of contamination. It is very improbable, however, that we shall ever get a centrifuge with which it will be possible to spin out completely an organism of the size, roughly, of 0·1 μ.

The identification of the filterable viruses by staining methods is beset with fallacies, and the results obtained up to now have proved in the main disappointing. The microscope proved of very little value except in revealing contaminating microbes. It is possible that, with increasing knowledge of the ultramicroscopic organisms, we shall find that the doctrine of fixity of form holds here as well as with ordinary microbes. With regard to the cultivation of the filterable viruses, each virus must be considered by itself. The virus of pleuro-pneumonia is apparently the only organism of this group that grows readily on artificial media. The production of cloudiness in Noguchi tubes, which has been put forward as a proof of culture, so far as chicken sarcoma is concerned, is entirely erroneous.

The animal test provides the final proof of the presence of the organism in an inoculum. The difficulty of microscopic investigation in this field makes us fall back in a very special way upon animal experimentation. It is because ordinary laboratory animals are not susceptible or only slightly so to human filterable viruses such as measles or influenza that such small progress has been made. We shall be compelled to work at animal diseases if we want to discover a method of handling and identifying the very small microbes. This will, however, involve great expense and is open only to those who have ample funds behind them.

In addition to his opening address (which was circulated but not read) on the more general aspects of the filterable viruses, Dr. Gye also discussed some aspects of the recent work he has done in collaboration with Mr. J. E. Barnard on cancer. The mere conjunction of host and parasite does not necessarily produce disease. There are accessory factors that must be searched for. Some years ago Dr. Gye and Dr. Cramer investigated the accessory action of certain chemical substances in the production of gas gangrene, and Dr. Gye had formed the opinion that the conception of disease as being due to the conjunction of living organisms involving a non-living factor was capable of further development. In this way he was led to his experiments on cancer. Any theory of cancer had to provide an explanation of its particular specificity both as regards the animal species the tumour is able to attack, and the type of growth produced. Yet cancer can be looked at from some points of view as one homogeneous specific disease, which has probably some common cause underlying it. The difficulty of obtaining a theory of cancer capable of reconciling the "specificity" of new growths with the general properties they hold in common has been overcome, in Dr. Gye's opinion, by his experimental work on Rous's sarcomas.

The infective filtrates of ground-up Rous's tumours contain not the virus only, but also an accessory substance or substances which are necessary to produce the disease. The accessory substances are responsible for the more specific peculiarities of the tumour, such as its histological structure and the susceptibility of certain animals to it.

The actual virus is probably the same in every case, and by means of prolonged spinning in a centrifuge, the virus may be obtained apparently free from the other factors. By suitable treatment with chloroform the virus can be destroyed without affecting the "specific factor." Neither the virus nor the accessory factor is separately able to produce sarcoma. The fact that "virus factor" from human carcinoma is able to produce sarcoma in the chicken if reinforced by the "non-virus" or "specific" factor from Rous's tumour brings the infectious sarcomas into line with the mammalian tumours, which up to now have been considered by most authorities to be non-infectious.

Mr. J. E. Barnard followed Dr. Gye with an account of the optical part of the work they have done on cancer. He dwelt on the limitations of microscopical research into filter-passing viruses, and stated his opinion that the present dark ground illumination apparatus such as is used at the National Institute for Medical Research is of such perfection that further improvement in direct microscopy upon present lines cannot be expected. The method which has proved so valuable in his and Dr. Gye's work depends upon the use of an apparatus by which the object can be focussed in visible light, and by a mechanical device can be refocussed in any desired wave-length, and thus a photomicrograph is obtained using light with a very short wave-length. What is believed to be the virus of cancer has thus been photographed, and what are considered to be phenomena of growth were seen in the preparations. The real difficulties in the work depend upon biological rather than physical considerations. The material is, in fact, more important than the apparatus, and much depends upon the absorptive capacity for light of the media, and

of the virus itself. The study of the absorption of the material will be the key of further optical improvement in microscopy.

Dr. M. H. Gordon dealt with the problem of the filter-passing viruses in the light of his experimental work on vaccinia and variola. These diseases are particularly suitable for the preliminary attack on the problem since a small animal is available that is susceptible to the virus, and the lesions produced by the virus are so characteristic that there is no likelihood that they will be mistaken for accidental lesions. In his work Dr. Gordon decided that since the cultivation of the virus and any attempts to make it visible by microscopic means are beset with difficulties, the most promising line of attack is by the methods of immunity. Vaccinia also satisfied the criterion of particulate matter, and centrifugalisation can separate infectious material into layers of varying infectiousness. Vaccinia is filterable, but only with special precautions, *e.g.* after previous treatment of the material with trypsin.

Active immunity to vaccinia can be produced not only by normal living virus but also by means of heated attenuated virus. In rabbits a passive immunity can also be transferred. Agglutination and complement fixation experiments have been done with the virus and its immune serum. Agglutination of the virus is easily visible with the naked eye or with a hand lens. Preparations of the agglutinated material show objects which bear a close resemblance to those figured by Dr. Gye and Mr. Barnard in their paper on cancer. The use of the agglutination method has given some interesting results. Material from confluent smallpox and from the so-called Alastrim absorbs the agglutinin in the same way as the homologous virus of vaccinia. From the point of view of agglutination, the close relationship, if not identity, of these three diseases was confirmed. Dr. Gordon finds a very striking susceptibility of vaccinia virus to potassium permanganate, which is more destructive than the customary disinfectants. Potassium permanganate in 1 in 100,000 dilution destroys the virus in a short time. This curious susceptibility of the virus may, indeed, to some extent, explain the result credited to this drug in the treatment of smallpox. Dr. J. E. McCartney stated that in the case of herpes virus he has been unable to separate virus from its suspension fluid by means of spinning. This he ascribed to the activity of the virus at much greater dilutions than that of the sarcoma or vaccinia viruses.

As was to be expected from the great interest that has recently been taken in the action of light and other physical agents in medicine, this subject was also prominent at the Bath meeting. Three discussions dealing with different aspects of this subject were included in the programme. Prof. S. Russ opened a discussion on the pathological basis of treatment by radiation with a general statement of the physical problems involved. Dr. E. T. Strangeways gave an account of experiments on the effect of X-rays on the division and development of tissue cells grown *in vitro*. He has been able to kill chick embryos while in the shell with X-rays, though after death of the embryo as a whole, successful tissue cultivation could still be made.

Miss M. E. Hume discussed the action of ultra-violet light on rickets, and the relation of light effects due to vitamin A. Dr. Canti described the action of radium on the mitosis of cells in human carcinoma.

In the Section of Therapeutics, Prof. W. E. Dixon opened a discussion on the therapeutic action of light; and in the Section of Public Medicine, Prof. Leonard Hill dealt with the influence of sunlight and artificial light on health. In all these communications there was the healthy sign that this branch of medicine, which a short time ago was in an empirical state, is now rapidly being co-ordinated on a scientific and experimental basis. Prof. Russ's concluding remarks seem to sum up the present position with regard to this branch of experimental medicine. "There is nothing so depressing as being told that we are only at the beginning of the subject. I do not think that this is the case, but rather that we are well in the middle of it."

Strong Electrolytes.

A SERIES of papers on the activities of strong electrolytes, by G. Scatchard, appears in the Journal of the American Chemical Society for March. The activity of hydrochloric acid was obtained from measurements of the E.M.F. of the cell $Pt(H_2)/HCl, AgCl/Ag$. The hydrogen electrode was of a rocking pattern suitable for use in a thermostat and simplified by the absence of a liquid junction. The activity coefficients obtained agree with those calculated from Randall and Vanselow's freezing-point measurements; the values at low concentrations are consistent with Debye and Hückel's limiting equation, the theoretical value of the constant in that equation being retained. The activities of potassium, sodium, and lithium chlorides are also considered; the existing data are compared and discussed in the light of Debye and Hückel's theory.

Individual ion activities have always been calculated through one of three assumptions, namely, (1) that the activities of the ions in a uni-univalent electrolyte are equal; (2) that the above is true in the case of potassium chloride, and that the activity of an ion depends only upon the total ionic concentration and not on the ions with which it is associated; (3) that the saturated potassium chloride bridge eliminates liquid-junction potentials. Assumptions (1) and (2) are in general incompatible; assumption (3), however, is quite distinct and is compared with the first two by G. Scatchard by measuring the E.M.F.'s of the cells, $Pt(H_2)/HCl, AgCl/Ag$ and $Hg/HgCl, KCl(sat.)/HCl\ AgCl/Ag$, the latter containing a flowing junction.

The results indicate that assumption (2) above is correct and that the saturated potassium chloride bridge gives a liquid-junction which does not vary with the acid concentration. The liquid-junction potential alters slightly on stopping the flow. In more concentrated solutions the chloride ion appears to attain a maximum activity, whilst that of the hydrogen ion appears to drop to a minimum value. The results obtained enable certain single electrode potentials to be accurately calculated.

From a series of papers by H. S. Harned on the subject in the same issue of the Journal of the American Chemical Society, the activity coefficient and the vapour pressures of the solutions are calculated from the E.M.F. of the cell $H_2/NaOH(c_1)/NaHg/NaOH(c_2)/H_2$. The activity coefficient of potassium hydroxide is greater than that of sodium hydroxide at concentrations greater than 0·05 molar. In the presence of sodium chloride the logarithm of the activity of the hydroxide (concentration less than 0·5 molar) is a linear function of its concentration at constant total molality. For potassium hydroxide in potassium chloride solution the activity coefficient is greater than that of sodium hydroxide in a sodium chloride solution when the hydroxides and salts are at the same strength. W. Lucasse records the activity coefficients and transport numbers of the alkaline-earth chlorides in the same journal.

The Sixth International Congress of Photography.

DURING the period June 29–July 6 there was held in Paris an International Congress on Photography, the purpose of which was to consider questions of standardisation in both pure photography and cinematography. The last Congress was held in Brussels in 1910, and was to have been succeeded by a Congress in London in 1915, but unfortunately the War intervened.

One of the reasons for holding the Congress this year in Paris was that it is the centenary of the discovery—according to French claims—of photography by Nicéphore Niepce; at the same time a plaque to the memory of Daguerre was unveiled. Attending the Congress were delegates from the United States, Belgium, England, France, Germany, Holland, Italy, Japan, Spain, and other countries. It was especially noticeable that there was nothing wanting in the cordiality with which the Germans were received; political questions were entirely put aside, it being realised that all the members had met for the furtherance of a common cause. Discussions were carried on in English, French, and German.

The Congress was opened on Monday afternoon, June 29, by Prof. Fabry of the Sorbonne, who is at the same time the president of the French Photographic Society. One delegate from each of the countries represented was elected as vice-president, and these presided in turn at the various sessions. The general arrangements were in the hands of MM. Clerc, Labussière, and Lobel.

For some time previous to the Congress an English committee, appointed by the Royal Photographic Society, had been at work in drawing up recommendations with respect to: a standard light source; exposure mechanism; development and subsequent treatment; the measurement of density; and the interpretation and statement of results. These recommendations were submitted to the Congress committee in sufficient time for them to be translated into French and German and circulated among the members. Recommendations were also received from the Optical Society of America with respect to the standard light source. It is significant that these recommendations formed the main basis of discussion. Agreement was arrived at between the various interests represented, and definite resolutions, embodying most of the recommendations of the English committee, were passed, but will not come into force until after a period of six months. The cinematography section was also able to harmonise the various points of view held by the different countries represented. An international executive sub-committee was appointed, with M. Clerc as secretary, and it was resolved that the next Congress should be held three years hence, and that the place of meeting should be, if possible, in London.

In addition to the various meetings of the sections there were functions of a less arduous character, including a reception at the Hôtel de Ville de Paris by M. Guillaumin, President of the Municipal Council, and a soirée, in the large amphitheatre of the Sorbonne, to commemorate the centenary of the invention of photography, at which the President of the French Republic, M. Doumergue, was present. A visit was made to the works and studios of M. Gaumont, and there were motor-car excursions to Ermenonville, Chaalis, and Senlis, and to the forest and chateau of Fontainbleau. The actual proceedings of the Congress were terminated on Saturday, July 4, by the usual banquet. T. SLATER PRICE.

Fishery Investigations.

THE Ministry of Agriculture and Fisheries has recently issued a report on sea fisheries for the years 1919–23, the last one (for the period 1915–1918) being published in 1920. This is a great pity, because both reports have been so very interesting. The 1920 report gave an engrossing account of the part played by British fishermen in the War, while the present one (H.M.S.O., 1925, 3*s*. 6*d*. net) deals, in an equally agreeable way, with the gradual settling down towards normal conditions of the sea-fishing industry. Statistical tables, summarising the catches made and other numerical results of the Ministry's work, have been issued each year, and the report now available discusses, in a general way, the information that has been collected. There is a very good summary of the scientific investigations made during the post-War years, and there are a number of clear financial statements showing the cost of the various kinds of work, administrative, developmental and scientific, undertaken by the Ministry.

Three parts of the Ministry's publication, "Fishery Investigations," have recently been published. No. 6, vol. 6, Ser. II., "The Annual Cycle in the Life of the Mature Cod in the North Sea," by Michael Graham and collaborators, deals with the investigations, biological and statistical, made during the last few years (H.M.S.O., 1924, 13*s*. net). No. 2, vol. 7, Ser. II., "Report on Exploratory Voyages to Lousy Bank and Adjacent Areas," by Lieut. Pawsey, G. T. Atkinson, and H. H. Goodchild, describes some very careful work done in the investigation of a new fishing-bank north from Rockall (H.M.S.O., 1924, 3*s*. net). No. 6, vol. 7, Ser. II., "Report on the English Plaice Investigations in the North Sea during the Years 1921–1923," by J. O. Borley and Miss D. E. Thursby-Pelham (H.M.S.O., 1925, 13*s*. net), is a very clearly written and readable account of the investigations that have been made since the War on the apparent increase in the plaice stock of the North Sea as a result of the great decrease in fishing during the period of military operations and restrictions. The results of the international inquiries and the recommendations that were made are also given. It contains a very good bibliography and is a very important work.

Some notable publications of the International Council for the Exploration of the Sea have also appeared recently. Dr. Martin Knudsen has prepared a *Bulletin Hydrographique* (1924), dealing in a general way with the observations made during the years 1920–1–2–3. Dr. Ed. le Danois has edited the *Rapport Atlantique* (*Rapports et Procès-Verbaux*, vol. 35, January, 1925). This contains the results of the investigations made by the "Atlantic Slope Committee," and it includes a very interesting discussion of the transgressions of Atlantic oceanic water into the shallow European seas. There is a discussion of the relation of this oscillatory movement of superficial Atlantic water to the long periodic tides. *Publication de Circonstance*, No. 84 (1924), is a description, in English, by Messrs. Ostenfeld and Jespersen, of the "standard plankton net" which was to have been designed by the late E. W. Nelson. The instrument is a modified "Nansen net," hauled in the way devised by Mr. H. J. Buchanan Wollaston of the English Fishery Investigations Staff. J. J.

University and Educational Intelligence.

AN Aitchison Memorial Scholarship, of the value of 36*l.* and tenable for two years in the full-time day course in technical optics, at the Northampton Polytechnic Institute (London), is being offered to students of both sexes. The examination will be held on September 22 and 23. Particulars can be obtained from the Hon. Secretary and Treasurer, Mr. Henry Purser, 42 Grays Inn Road, London, W.C.1.

THE Air Ministry announces that the next examination of candidates for entry as flight cadets to the Royal Air Force Cadet College, Cranwell, will begin on November 17, when 35 cadetships will be offered. Forms of entry, which can be obtained from the Secretary, Civil Service Commission, Burlington Gardens, W.1., will not be accepted later than September 17. Candidates must be medically fit and be between the ages of 17½ and 19½ years. Cadets undergo a two years' course at the College, where, in addition to continuing their general education, they receive a thorough training in all questions concerning military aviation and cognate subjects, and also graduate as service pilots. Full details as to entry into Cranwell are contained in Air Publication 121, Regulations for admission to the Royal Air Force Cadet College (H.M. Stationery Office, Kingsway, W.C.2, 6*d.* net).

THE universities receive each year from the grant-aided schools in England and Wales 4½ per cent. of the total number of pupils leaving the schools. The president of the Board of Education recently directed attention to this percentage as being abnormally small. In the United States, according to an article in the April issue of *School Life*, 350,000 boys and girls—six times as many as a quarter of a century ago—will be completing their public high-school course this year, and of this number 112,000 will go to college and 50,000 will enter other institutions to continue their education. This abundant supply of recruits for post-secondary education affords evidence of widespread prosperity, but their acceptance is not an unmixed advantage either to them or to the institutions receiving them. The president of the Carnegie Foundation for the Advancement of Teaching says in his annual report for 1923–24 that the colleges and professional schools admit each year a growing army of high-school graduates who lack the qualities of intellectual training which would fit them for fruitful college study, for they have not learned to use their minds. This is in some measure due to the gradual substitution of a new ideal of the meaning of a liberal education for the old-time conception of training the habits and powers of the mind. The mere acquisition of knowledge, formerly regarded as a secondary matter, has become the main thing. "Our high schools and colleges seek to give their pupils something from every field of thought. Following the advice of Herbert Spencer they labour to present these packages of knowledge in the most agreeable forms. The text-books offer every variety of predigested knowledge. . . . It is exactly the reverse of that intellectual training which the study of science ought to bring." One of the most pressing needs of the time, moreover, is to diminish the subserviency of the school to the college and to open up from the elementary and from the secondary schools leadings to technical schools in the trades, in agriculture, and in the arts. The vocational courses given in the high school are no substitute for "the sharp, precise training that makes for the sort of technical skill that adds joy to work and is one of the most prolific sources of human happiness."

Early Science at Oxford.

August 12, 1684 (*continued*). Dr. Alexander Pudsey, Fellow of Magdalen College, subscribed to ye Articles, and then sate as President.

Dr. Plot communicated some of ye bark of ye clove tree; it had a strong aromatick tast, very much like cloves, and very differing from Cinnamon, which has sometimes been thought to be ye bark of this tree. He communicated also some patterns of ffirr, taken up in ye old *dewet pool*, in ye parish of Norbury in Staffordshire, so full of Turpentine, that it is transparent; this is that which they use as candles. and may well be thought to have adventitious Bitumen from ye moores, wherein it lies; for forreign firr is not so transparent, will not burn so well; and that this is firr, appears very probable, because some of ye trees taken up, have six branches at ye annuall distances, which, as ye Doctor thinkes, no trees, but firrs, have.

August 19, 1684. The Society being met, ye following experiments were tried, by Mr. Musgrave.

Human spittle, clarified by standing, being mix't with syrup of violets, turned to a delicate *green* color. Part of a Mucous substance, taken out of ye Stomach of a Jack near ye Pylorus, and mixt with solution of sublimate, became much whiter, than it was before. Another part of it, mix't with syrup of violets, turned *green*.

The same person has observ'd like effects, by mixing a liquor found in ye stomach of a *Hedghog*, with syrup of violets, and with solution of sublimate.

These Experiments are urged as an argument against ye existence of an *acid ferment* in ye stomach. It seems probable, that ye great worke of Digestion proceeds from a *volatile alcali*.

He also tooke notice of a large *bed of Glands*, makeing about ye ⅜ths of ye inside of ye stomach, and seated near ye pylorus, of a Jack; the whole bed appears of a brownish red color, and is divided into severall Ridges, which run parallel to one another, and ye same way with ye stomach; for ye better contraction of that part especially when empty, (at which time these Glands being fix'd to the inmost coat, are, together with it, drawn up into wrinkles), that edge of this bed of glands, which is nearest ye head of ye fish, is dented, ye ridges breaking off on a sudden; but at ye other end, on this side ye Pylorus, they diminish almost insensibly.

By these Glands, he supposes, at least a considerable share of ye menstruum (the great efficacy of which makes this fish a fit subject to illustrate ye nature of Digestion) is seperated from ye blood; for blood vessels may be seen in great numbers on ye other side of ye glands, and inner tunic, by seperating it, and them, from the middle and musculose tunic; and, as a farther argument of this use of ye glands, he has observed, that that part of ye stomach where they are, is generally moister, then the other part near ye mouth; and that, in dissecting Jacks, whose stomachs have been filld with some large fish of ye pinnaceous kind, (which must enter with ye head foremost) ye head, and foremost parts, of ye devoured fish, have, as far as the glands reach, been either actually dissolv'd, or fairly turning, into a mucilage; whereas, at ye same time, ye other, and less bony, part of ye included fish, being not yet come within ye power of the menstruum, has still retain'd its form, and consistence.

Mr. Walker presented ye Society with ye draughts, and descriptions, of two sorts of Wooden Bridges, contrived without any pillar under them, tho of a considerable length; these accounts will be printed very suddenly.

Societies and Academies.

LONDON.

Faraday Society, July 6.—A. L. **Marshall**: The electrodeposition of zinc from sulphate solutions. With pure solutions, the efficiency of zinc deposition always increases with rising temperature; an explanation based on chemical polarisation is given. A convenient copper coulometer has been developed for measuring currents up to 15 amperes or more.—J. B. **O'Sullivan**: The application of the quinhydrone electrode to the measurement of P_H valves in solutions containing copper ions and other divalent ions. The quinhydrone electrode can be employed in many cases in which the ordinary hydrogen electrode cannot be used on account of its greater reducing power. This applies not merely to salts of copper, which are electro-positive towards hydrogen, but also to neutral or weakly acid solutions of the salts of such metals as tin, lead and nickel. The quinhydrone electrode is itself limited in its applicability by its reducing power. Thus it cannot be employed even in moderately acid solutions of the salts of mercury, silver or gold, which have normal electrode potentials of more than 0·7 volt.—F. M. **Cray** and G. M. **Westrip**: The preparation of solutions of standard hydrogen ion concentration and the measurement of indicator ranges in an acetone-water mixture. Solutions of standard hydrogen ion concentration ranging from P_H 12·5-2·0 have been prepared and calibrated by means of the quinhydrone electrode in a solvent containing 10 volumes of water in 100 of acetone-water. These solutions have been used in the measurement of the P_H ranges of a large number of indicators in the specified solvent. Their behaviour in these standard solutions is consistent with their P_H values, as determined by the quinhydrone electrode, within 0·1 P_H.

DUBLIN.

Royal Irish Academy, June 22.—A. K. **Macbeth** and J. **Craik**: Condensation reactions of indoxyl and 3-oxy(1)thionaphthen. In the course of some work, a trustworthy method of estimating 3-oxy(1)thionaphthen was found necessary, and its condensation reactions with several aldehydes were therefore examined in some detail. Typical condensation products were formed by the interaction of the thioindoxyl and anthraquinone-2-aldehyde, 5-nitroanthraquinone-2-aldehyde, 1-chloroanthraquinone-2-aldehyde, and isatin. The condensations take place quantitatively and the thioindogenides produced are characterised by their high melting points and marked insolubility in organic solvents. The reactions are therefore of value in estimating 3-oxy(1)thionaphthen. The indogenides obtained by the condensation of indoxyl with anthraquinone aldehydes were prepared for comparison with the series of thioindogenides: the latter were all found to be yellow-coloured compounds in contrast with the deep-red or brown products obtained in the former case.

EDINBURGH.

Royal Society, June 22.—W. H. **Lang**: Contributions to the flora of the Old Red Sandstone of Scotland. (*a*) On plant-remains from the fish-beds of Cromarty. (*b*) On a sporangium-bearing branch-system from the Stromness beds. Plant-remains from the grey clay or micaceous sandstones of the Cromarty fish-beds include more than eight distinct types of spores and two types of sporangia found free in the rock. Some features of the vegetative organs of *Thursophyton Milleri* are described, but nothing is yet known of the reproductive organs of this plant. The smooth, branched axes are referred to *Hostimella* sp. and some of them have axillary structures like those recorded for *Hostimella hostimensis* from Bohemia. Two types of plants with attached sporangia containing spores are named provisionally *Hostimella globosa* and *H. pinnata*. Large oval sporangia, borne on a raceme-like branch-system, from the Stromness beds of the same age are named *H. racemosa*.—F. A. E. **Crew**: Rejuvenation of the aged fowl through thyroid medication. Cock-feathered cocks become hen-feathered: the plumage of hen-feathered cocks and of hens is unaffected save that there is an increased melanism. The egg-yield is increased and old birds are rejuvenated.—A. Crichton **Mitchell**: On the changes in vertical force during the "sudden commencement" of a magnetic storm. The "sudden commencement" of the slight magnetic storm of Sept. 4, 1924, was observed at Eskdalemuir Observatory by means of a large coil laid horizontally on the ground, the current induced in the coil by the sudden change in vertical force being recorded photographically by a galvanometer in the circuit.

ADELAIDE.

Royal Society of South Australia, May 14.—L. Keith **Ward**: Notes on the geological structure of Central Australia. The salient features of both the fundamental complex forming the core of the MacDonnell Ranges and of the sediments deposited upon these foundations in the central portion of Australia are described. The palæontological and stratigraphical data, when correlated, are regarded as proof of the exclusion of the supposed Cambrian system from the central area and the existence of an immensely thick series of Ordovician sandstones and limestones. These are overlain, in the southern part of the Northern Territory, by beds comprising glacial tillites—presumably of Permo-Carboniferous age. Then follow successively Jurassic sands, Lower and Middle Cretaceous shales, and recent deposits of fluviatile and æolian origin. A dense crust of chalcedonic silica caps alike the Ordovician, Permo-Carboniferous, and Cretaceous rocks. Glacial action in Upper Cretaceous time was widespread through the northern part of South Australia. The correlation of the formations described with those of adjoining regions is discussed, and the evolution of the structure outlined. The great central depression of Australia exerted an important influence on the development of the drainage system.

CAPE TOWN.

Royal Society of South Africa, May 20.—S. H. **Haughton**: Tracks of animals preserved in the Ecca Shales of the Cape Province. The specimens are from two localities in the Ecca Beds, one in the Zak River area, Calvinia, and the other from the cutting (Ecca Pass) on the road from Grahamstown to Fort Beaufort, localities separated by a distance of 350 miles. The tracks include numerous crustacean foot-prints and the trails of worms. The vertebrate tracks consist in part of small groups of four-toed so-called "amphibian" prints, which lack a heel-pad; in part, doubtfully, of oval impressions with a finely corrugated surface, as if due to the impress of a skin-covered "hoof-like" foot; and in part of a series of peculiar parallel sinuous lines, possibly made by ventral spines of a fish armed after the fashion of the Carboniferous and Permian Acanthodes.—J. H. **Power**: Notes on the habits and life-histories

of certain little-known Anura with descriptions of the tadpoles. *Cassina Senegalensis*, *Phrynomantis bifasciata*, and *Bufo carens*, collected by Lobatsi, are described. The tadpole of Cassina was observed to devour mosquito eggs.—F. von **Huene**: Some additions to the knowledge of Procolophon, Lystrosaurus, Noteosuchus, and Cistecephalus. An impression of the skin surrounding the parietal foramen of a specimen of Procolophon shows small polygonal pits bounded by thick meandering walls. The large parietal foramen possibly contained a functional organ. The skull of Lystrosaurus contains a transverse bone (ectopterygoid) in the same position as in Dicynodon.—K. H. **Barnard**: Report on a collection of Crustacea from Portuguese East Africa. The present collection contains 57 species, of which 14 have been previously recorded. The capture of a crayfish of the genus Palinustus, hitherto known only from the West Indies, and of three Indo-Pacific forms not reported since their discovery by the *Challenger*, are the most striking results. Two new varieties and two new species are described.—J. **Groves** and Edith L. **Stephens**: New and noteworthy S.A. Charophyta. South Africa is rich in endemic types belonging to the group, some of them of outstanding beauty and interest, and this paper describes six of these new species.—W. J. **Hodgetts**: Contributions to our knowledge of the freshwater algæ of Africa. No. 6: Some freshwater algæ from Stellenbosch. 184 species are recorded, and nine species, eight varieties, and several forms are described as new. The most striking feature of the collection is the relatively large number (53) of species of desmids, a group rather scantily represented in collections from other parts of South Africa.—F. G. **Cawston**: Some observations of the radulæ of freshwater Mollusca. The cones and cusp-formation of the radulæ of freshwater mollusca which serve as intermediate hosts for Trematoda in South Africa are described.

ROME.

Royal Academy of the Lincei, May 2.—Guido **Fubini**: Varieties with collinear plane sections.—Gino **Fani**: The surfaces of space S_3 with collinear plane sections.—S. **Pincherle**: Certain functional transformations.—Leonida **Tonelli**: Green's theorem.—M. La **Rosa**: Experimental foundations of the ballistic principle applied to the velocity of light.—M. **Cisotti**: Dynamic effect of a current flowing between a cylinder and an undefined plane wall.—O. M. **Corbino** and E. **Persico**: Influence of a magnetic field on the action of a three-electrode lamp.—Luigi **Fantappiè**: Linear analytic functionals and their singularity.—Luigi **Fantappiè**: The derivation of analytic functionals.—S. **Finikoff**: The principal surfaces of Bianchi's rectilinear congruences.—Letterio **Laboccetta**: Analytic representation in finite form of the functions the diagrams of which consist of a succession of arcs of different lines varying according to a definite law from one interval to the next.—D. J. **Struik**: Rigorous determination of the periodic irrotational waves in a channel.—R. **Serini**: Capacity of the electric condenser with infinitely thin circular plates.—F. De **Carli**: The capacity for reaction in the solid state of anhydrides and metallic oxides. The reactivity of anhydrides with metallic oxides in the solid condition is general and varies with the nature of the reacting oxides, being most marked with oxides of the alkaline earth metals and also with boric, molybdic, tungstic, vanadic, and silicic anhydrides.—Emilio **Oddone**: Alterations caused in isobaric configurations by calming of the air.—G. **Brunelli**: Autotomy of the posterior lobe of the vitellin sac in *Salmo salar*, L.—Silvio **Ranzi**: An organ of sense derived from the first epibranchial placoid of Selachi.—Filippo **Eredia**: Forecast of the almond crop of any season on the basis of the air temperature and rainfall in the three months January to March inclusive.—Primo **Dorello**: The functions of the peduncle, diverticulum, and Swammerdam's vesicula in the genus Helix.

May 17.—Guido **Fubini**: An observation of the transcendent $d(z)$ of Pincherle.—Francesco **Severi**: Theory of the correspondence between algebraic curves.—U. **Cisotti**: Dynamic effect of a current circulating round a cylinder in a tunnel.—Fil. **Bottazzi** and L. De **Caro**: Variations produced in the electrical resistance of the muscles by various physical and chemical agents. The results are given of investigations on the influence of temperature on the electrical resistance of muscle and essentially connective membranes, and on the isoelectric point of muscular colloids.—Seb. **Timpanaro**: Experiments on floating laminæ.—G. **Scagliarini**: Additive compounds of stannic iodide and organic bases.—P. **Comucci**: Azurite from Pistello (Elba).—G. **Brunelli**: Significance of the oily drops in the egg of Teleostei and location of the oxidases.—G. **Amantea**: Investigations on the spermatic secretion. xvi. Collection of the sperm and elimination of the spermatozoa of the pigeon.—Umberto **D'Ancona**: Double innervation of the muscles of the decapod crustaceans.—V. De **Laurenzi**: Parotid secretion in man caused by various peripheral factors.—Nazzareno **Grisogani**: Rhythm of the parotid secretion in man, and gustatory and olfactory sensations.—Cesare **Artom**: Abnormal segmentation at the commencement of development in the egg of Cagliari's *Artemia salina diploide*.

SYDNEY.

Linnean Society of New South Wales, April 29.—G. H. **Hardy**: Australian Mydaidæ (Diptera). A descriptive and synonymic catalogue of the dipterous family Mydaidæ, containing two genera and nine described species recognised as valid.—J. R. **Malloch**: Notes on Australian Diptera, No. v. Keys are presented for the recognition of the genera of Muscidæ known from Australia, together with a key for the species of Helina, of which four are described as new.—F. G. **Clapp**: A few observations on the geology and geography of North-west and Desert Basins, Western Australia.—A. H. K. **Petrie**: An ecological study of the flora of Mount Wilson, Part II. The Eucalyptus forests. The Eucalyptus forests form the main plant-covering of the sandstone plateau, and also occur on the outskirts of the basalt residuals. Discussing the ecology of Eucalyptus forests, special reference is made to their relation to fires. Further observations are also recorded on the stratum-societies of the junction flora, with a special discussion of the status of the Pteridium society.

Royal Society of New South Wales, May 6.—C. **Anderson**: The Australian fauna (Presidential address). The fauna has often been described as the most interesting and important in the world. Australia became separated from other continental masses in late Cretaceous or very early Tertiary times, and, protected by their isolation from the competition of later and higher forms, the animals of Australia are in many instances archaic survivals, which are closely related to forms long since extinct

in other lands. The dispute as to the route whereby the marsupials and other forms entered Australia will probably be settled only by further discoveries, particularly in palæontology.

VIENNA.

Academy of Sciences, May 7.—Ph. **Furtwängler**: On minimal bases for bodies of rational functions.—F. **Hemmelmayr** and T. **Meyer**: The influence of various substitutes on the tenacity of the carboxyl group in substituted aromatic acids, the influence of a second carboxyl group and the relative activity of chlorine and bromine.—C. **Diener**: Geological investigations on the Millibrunnkogel near Aussee in Styria.—A. **Blumenstock**: On the preparation of stearolacton.—J. **Lindner** and A. **Siegel**: The course of the chinaldin synthesis in the tetralylamines, 7, 8-tetra-methylen-chinaldin.—J. **Lindner** and M. **Staufer**: The course of chinaldin synthesis in β-amino-tetralin.—G. **Weissenberger**, F. **Schuster**, and H. **Pamer**: On organic molecular compounds. (xiii.) Studies on the calculation of vapour pressure curves.—K. **Mayrhofer**: Representation of a complex of rays by a dual quadratic differential form.

WASHINGTON, D.C.

National Academy of Sciences (Proc., Vol. 11, No. 5, May).—W. C. **Boeck** and J. **Drbohlav**: The cultivation of *Endamœba histolytica*. An organism from human fæces, which agrees with *E. histolytica* in movements, nutrition, morphology, and pathogenicity, has been cultivated on Locke egg-serum and Locke egg-albumin. *E. histolytica* in culture feeds on bacteria and blood corpuscles, if they are present. The cultured organisms were as pathogenic to kittens as fresh material.—S. F. **Chiang**: The rat as a possible carrier of the dysentery amœba. Rats can be infected with *E. histolytica* of human origin by feeding material containing cysts. Infection is transmitted readily from rat to rat by association in the same cage, and may persist for four months. Apparent varieties of *E. histolytica* occur spontaneously in laboratory rats. The rat may therefore be a possible carrier of the causal organism of amœbic dysentery.—L. P. **Eisenhart**: Linear connexions of a space which are determined by simply transitive continuous groups.—J. W. **Alexander**: Note on a theorem by H. Kneser.—L. **Ingold**: Associated types of linear connexion.—J. M. **Thomas**: Conformal correspondence of Riemann spaces.—C. **Barus**: Pinhole probe measurements of the phase change of the telephonic end plates, acting on a closed cylindrical air column in longitudinal acoustic vibration.—E. B. **Wilson**: On the Boltzmann equation $\rho=\rho_0 \exp.(-w/kt)$.—H. **Kahler**: The band spectra of crystals and complex gases.—E. B. **Wilson** and W. J. **Luyten**: The frequency distribution of some measured parallaxes and of the parallaxes themselves. 313 determinations of parallaxes of stars between magnitudes 5 and 6 were used. On probability paper, the distribution gives a straight line within the errors of sampling. Graphs are given of the frequency distribution on a parallax base.—E. W. **Brown**: The effect of varying mass on a binary system. If rate of change of momentum equals force, angular momentum remains constant while a real velocity increases, and, unless the two masses are equal, the velocity of the centre of mass increases. The hypothesis thus provides for increase of velocity of the star with age (Russell's scheme of evolution) and the velocity of a single star relative to the centre of mass of the whole stellar system will decrease.

Official Publications Received.

Joint Board of Research for Mental Diseases: City and University of Birmingham. Annual Report of the Laboratory for Year ending March 1925. Pp. 11. (Birmingham.)

Papers from the Geological Department, Glasgow University. Vol. 7, 1924. Pp. iv+302. (Glasgow: Jackson, Wylie and Co.)

Proceedings of the American Academy of Arts and Sciences. Vol. 60, No. 1: The Geology of Ascension Island. By Reginald A. Daly. Pp. 80+21 plates. (Boston, Mass.) 3 dollars.

University College of South Wales and Monmouthshire: Faculty of Science. Information regarding Courses and Careers open to Students of Science. Pp. 22. (Cardiff.)

His Majesty's Stationery Office, 1786–1925. Brief Guide to Government Publications. Pp. 84. (London: H.M. Stationery Office.) 3d. net.

Publikace Pražské Státní Hvězdárny (Publications de l'Observatoire National de Prague). No. 1: Troisième étude sur l'appareil circumzénithal. 1ère partie: Sur le principe et sur les développements possibles de l'appareil. Par Fr. Nušl. Pp. 20. No. 2: Troisième étude sur l'appareil circumzénithal. 2ème partie: Construction de l'appareil; modèle transportable 1922. Par Josef Jan Frič. Pp. 19. No. 3: Comparaison mondiale des pendules; fractionnaire. Par Fr. Nušl. Pp. 10. (Prague.)

Publications of the Kapteyn Astronomical Laboratory at Groningen. No. 36: The Number of Stars between definite limits of Proper Motion, Visual Magnitude and Galactic Latitude for each Spectral Class. By Prof. Dr. P. J. van Rhijn. Pp. 16. No. 37: Comparison between Trigonometric, Spectroscopic and Mean Statistical Parallaxes. By Prof. Dr. P. J. van Rhijn. Pp. iii+31. No. 39: The Proper Motions of 656 Stars, derived from Plates taken at the Helsingfors Observatory, measured and discussed by W. J. Klein Wassink. Pp. 25. (Groningen: Hoitsema Bros.)

Government of Madras: Local Self-Government Department (Public Health). Chemical Examiner, Madras, Annual Report, 1924. Pp. 14. (Madras.)

Norman Lockyer Observatory. Director's Annual Report, April 1, 1924–March 31, 1925. Pp. 8. (Sidmouth.)

The Norman Lockyer Observatory, Salcombe Hill, Sidmouth. Council's Report and Accounts, and List of Council, Staff, Members, etc., June 1925 (as adopted at Annual General Meeting, June 11th, 1925). Pp. 8. (Sidmouth.)

Catalogue of Indian Insects. By T. Bainbridge Fletcher. Part 7: Lasiocampidæ. Pp. 29. 10 annas; 1s. Part 8: Amatidæ (Syntomidæ). Pp. 35. (Calcutta: Government of India Central Publication Branch.)

Transactions of the South Indian Branch of the British Medical Association. Vol. 17, No. 3. Pp. 105-161. (Madras.)

Department of the Interior: Bureau of Education. Bulletin, 1925, No. 6: High School Education of the Farm Population in selected States. By E. E. Windes. Pp. 24. (Washington: Government Printing Office.) 5 cents.

The Rockefeller Foundation: a Review for 1924. By George E. Vincent. Pp. 48. (New York City.)

Transactions of the Royal Society of Edinburgh. Vol. 53, Part 3, No. 32: The Continuity of the Vertebrate Nervous System; Studies on Lepidosiren Paradoxa. By Frances M. Ballantyne. Pp. 663-670+6 plates. (Edinburgh: R. Grant and Son; London: Williams and Norgate, Ltd.) 3s.

The Rowett Research Institute. Collected Papers. Vol. 1. Edited by Dr. John Boyd Orr. Pp. 575. (Aberdeen: Reid Library of the Rowett Research Institute.) 21s.

Uganda Protectorate. Annual Report of the Geological Survey Department for the Year ended 31st December 1924. Pp. 13. (Entebbe.)

Denkschriften der Schweizerischen Naturforschenden Gesellschaft: Mémoires de la Société Helvétique des Sciences Naturelles. Band 59 (Vol. 59): Beiträge zur Kenntnis der Skelettbildung bei domestizierten Säugetieren auf Grund röntgenologischer Untersuchungen; Anlage und Entwicklung des Knochenskelettes der Vorder- und Hinterextremität des Hausrindes (Bos taurus L.). Von Max Küpfer und Hans R. Schinz. Pp. viii+133+28 Tafeln. Band 60, Abh. 1 (Vol. 60, Mém. 1): Die Hemipterenfauna des Schweizerischen Nationalparkes (Heteropteren und Cicadinen). Von Dr. B. Hofmänner. Pp. xii+174+2 Tafeln. Band 61, Abh. 1 (Vol. 61, Mém. 1): Die Magdalénien-Station bei Ettingen (Baselland). Von Fritz Sarasin und H. G. Stehlin. Mit einem Nachtrag zur Faunula der Magdalénien-Station am Schlossfelsen von Thierstein, von H. G. Stehlin. Pp. vi+137+16 Tafeln. (Zürich: Gebrüder Fretz A.-G.)

The Journal of the Ipswich and District Natural History Society. Vol. 1, Part 1, June. Edited by Henry Ogle. Pp. viii+68. (Ipswich.)

The Institution of Gas Engineers. Eleventh Report of the Gas Investigation Committee: Aeration and Air Injection, Part 2. Pp. 63-108. Twelfth Report of the Gas Investigation Committee: Waste Heat Boilers. Pp. 109-168. Institution Gas Research Fellowship, 1924: The Gasification of Coke in Steam, with Special Reference to Rates of Gasification and the Composition of the Gas. By Dr. S. Pexton and Prof. J. W. Cobb. Pp. 292-325. (London.)

University of California Publications in Zoology. Vol. 27: A Synopsis of the Amphibia of California. By Tracy I. Storer. Pp. v+342+18 plates. (Berkeley, Calif.) 4.50 dollars.

Bulletin of the Experimental Station of the Hawaiian Sugar Planters' Association. Entomological Series, Bulletin No. 17: The Field Rat in Hawaii and its Control. By C. E. Pemberton. Pp. v+46. (Honolulu.)

Rainfall in Chôsen (Korea). Compiled by the Meteorological Observatory of the Government-General of Chôsen. Pp. 186+27 maps. (Zinsen, Chemulpo.)

Koninklijk Magnetisch en Meteorologisch Observatorium te Batavia. Verhandelingen No. 8: Het Klimaat van Nederlandsch-Indië (The Climate of the Netherlands Indies). Door Dr. C. Braak. Deel 1 (Vol. 1), Algemeene Hoofdstukken (General Chapters), Aflevering 8 (Part 8). With English Summaries. Pp. iii+499-528+249-272. Verhandelingen No. 13: Isomagnetics for the Netherlands East Indian Archipelago, Epoch 1925.0. By Dr. S. W. Visser. Pp. ii+18+4 plates. Verhandelingen No. 16: Some Researches into the Propagation of Seismic Long Waves. By Dr. S. W. Visser. Pp. ii+24. (Batavia.)