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Sex Economics.

IN his presidential address to the Section of Economics of the British Association at the recent meeting at Hull, Prof. F. Y. Edgeworth did not hesitate to plunge into the midst of a raging current controversy. "Should men and women receive equal pay for equal work?" were his opening words, and his conclusion is that they should "with some reservations and adjustments."

This conclusion is reached in two stages as follows. In a first approximation Prof. Edgeworth relegates dependants to limbo, and shows—we think conclusively—that, granted that freedom of competition for jobs is generally conducive to the best possible distribution of labour, then there is no reason why such competition should be confined to one sex; though it must be a regulated competition, controlled by collective bargaining, in which "the oppressive action of male Trade Unions" is "counteracted by pressure on the part of women acting in concert." The overcrowding of women into those occupations which are open to them, which has resulted from restrictions upon their freedom to compete on equal terms with men in all spheres, is in fact socially uneconomic as well as unfortunate in its effect upon the women's own wages. Prof. Edgeworth goes on to surmise that given substantial freedom of competition we shall find (*a*) occupations almost wholly male, (*b*) occupations into which both men and women enter freely, and (*c*) occupations almost wholly female. He submits that the average of weekly earnings in (*a*) will continue to be above the average of weekly earnings in (*c*), while in (*b*), though the rate of pay for a unit of work will be the same for both sexes, the average weekly earnings of the male will continue to be above the average weekly earnings of the female.

Prof. Edgeworth does not offer any particular evidence of these suggestions, which rest upon an assumption that at present, or rather "for a short period in the immediate future," the industrial efficiency of women must be generally inferior to that of men. In point of fact, practically no scientific investigation has yet been made of the relative efficiency of men and women in different occupations. Nor, in view of the close and long-standing restrictions upon the field of women's labour, does the actual distribution of the sexes between different occupations throw much light upon the problem. In quoting the usual examples of telephony, typewriting, textiles, and nursery duties as the female *fortes*, Prof. Edgeworth seems to be allowing convention rather than science to be his guide.

Wise advocates of women's rights will, however,

agree with Prof. Edgeworth when he points out where other things are equal an employer is likely to have a preference for the male owing to the "secondary" drawbacks of the female. Prejudice and restricted opportunities may be responsible for what truth there is in the charge that "a woman is not so useful in the case of a breakdown or a runaway." But it is quite indisputable that the probability of her early marriage is a real drawback to a woman's industrial efficiency. These secondary differences, however, are so difficult to measure accurately that the reduction on their account of the woman's rate per unit of work below that of the man is not a wise or scientific policy. It is better to allow them to make their influence felt upon the occupational distribution of the sexes rather than upon their pay. Of the "tertiary" differences also (of which the illustration given is "the presence and influence of a master—as contrasted with a mistress—in dealing with the bigger boys") the same is true; but there is no evidence to show whether these tertiary differences predominantly favour the male rather than the female.

We now restore the abstracted circumstances of family life. A man normally has, or expects to have, a family to support; a woman normally has not. While the average number of dependants supported by a woman from her earnings has often been greatly underestimated, there is certainly no disputing the general result of Messrs. Rowntree and Stuart's figures, which show that this average is much higher for a man than for a woman. The candid will admit that here is the real obstacle to equal pay for equal work; the logical will consider the possibilities of endowment of motherhood as a way out of the difficulty. Prof. Edgeworth summarises the *pros* and *cons* of State endowment of motherhood as follows. The proposal is attractive because (1) it would for the first time make competition between the sexes both free and fair; and (2) it would make possible the distribution of resources in such a way as to meet the requirements of the larger family better than is done at present, when the wage paid to a man tends to be adjusted to the presumption that he maintains a family of approximately 4·4 persons, which he quite certainly does not. Against these advantages Prof. Edgeworth sets the following: (1) the scheme is socialistic and bureaucratic, (2) it would almost certainly involve a transference of resources from the rich to the poor and would therefore probably check saving, (3) the effect on the contributor would be "depressing," and there would be (4) a great stimulus to population, and (5) no security for the improvement of the race, but only a prospect of "the ruin of the great middle class to which England owes so much."

We gather that Prof. Edgeworth regards these disadvantages as conclusive. He turns from the State endowment of motherhood to consider one or two other suggestions, the principal of which is his own proposal that the members of Trade Unions might themselves contribute a quota of their earnings to a fund to be distributed among the wives of members in accordance with the size of their families. In regard to this proposal Prof. Edgeworth does not commit himself beyond the canny statement that it would be much less open to objections than the endowment of motherhood by the State.

Prof. Edgeworth's address is open to little criticism from those who grant his premises. All will applaud his careful analysis of his subject. It is, however, at least open to question whether his whole treatment of the matter does not suffer immensely from the limitations which he has imposed upon himself. In his first approximation the assumption that "regulated competition" (a very vague concept) is a royal road to ideal distribution is open to serious criticism. Secondly, any discussion of endowment of motherhood which assumes outright that (*a*) transferences of resources from rich to poor would be entailed, and that (*b*) these are objectionable, rests on questionable ground. To the present writer this double assumption appears fatal to Prof. Edgeworth's conclusions regarding the right relation of the basis of payment to family circumstances.

BARBARA WOOTTON.

Fishing and Fishing Lore.

Fishing from the Earliest Times. By W. Radcliffe. Pp. xvii+478. (London: J. Murray, 1921.) 28*s.* net.

THE literature connected with fishing is already so extensive that a new volume is liable to be subjected to scrutiny to see whether it can justify its birth by furnishing new matter or new ideas. As the more obvious gaps in the literature of the subject become fewer, the tests will necessarily become more searching. Mr. Radcliffe's book, fortunately, can claim a definite *raison d'être*, and may receive an enthusiastic welcome as filling a decided gap, one which it is curious should have so long remained void. His aim has been to provide a history of the fishing art and craft from the earliest times down to about A.D. 500. The title scarcely does justice to the contents of this versatile volume, which is far from being restricted to the consideration of actual fishing practices. These, indeed, probably occupy but a third of the book. The remainder is very largely concerned with what may be classed as the folk-lore associated with fish, fishing, fishermen, and fish-consumers, and with other details

which are by-products of the industry. Mr. Radcliffe has been at great pains to bring together a great mass of material which he has collated and coaxed into a very readable form. The illustrations are both good and numerous. The result is an important work which is both entertaining reading, and of considerable value as a comprehensive book of reference. In the main, it consists of classified quotations which are analysed and evaluated by the author. One would gather that the author has thoroughly enjoyed his self-imposed task. He revels in argument, and while now and then he may, perhaps, be suspected of "special pleading," his interpretations of doubtful or obscure passages are always interesting and suggestive, even when he fails to be entirely convincing.

The introduction extends over sixty pages and deals with a number of points of general interest and with early prehistoric fishing. For our knowledge of fishing practices during the Stone and Bronze Ages we are dependent upon evidence which is, unfortunately, meagre in amount, and requires much speculation for the completion of the picture. Mr. Radcliffe has not made an intensive study of fishing as practised by *recent* Stone-age peoples, and he makes but slight use of the evidence which they can afford, valuable though it may be for the light which it can throw upon the archæological record. Ethnological data must be brought to bear upon archæological research if an adequate diagnosis of early customs and appliances is to be achieved. A comprehensive work dealing with fishing pursuits and methods among the recent "unrisen" peoples, the progress of whose more or less primitive culture has been arrested or retarded at various stages of advancement, still remains to be written. When such a work, based upon comparative study, is available, archæological commentarists will find a valuable ally which will assist materially in their interpretations of ancient data.

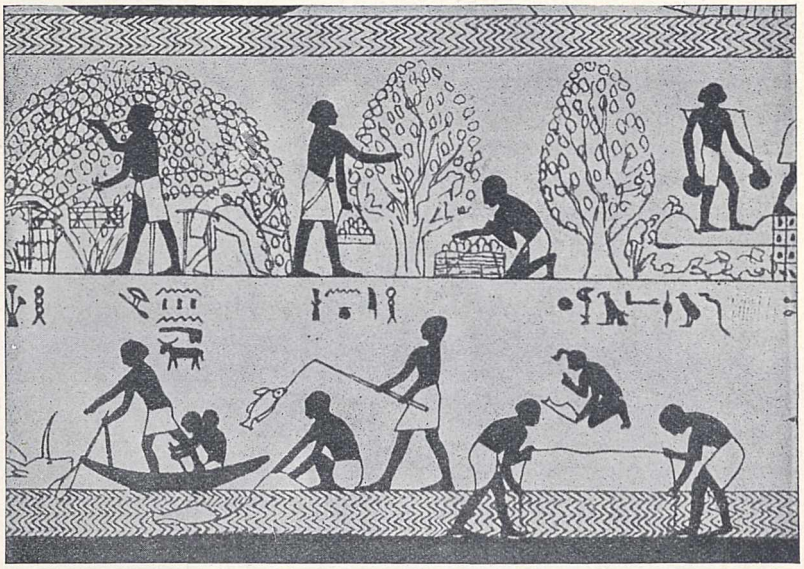

FIG. 1.—The earliest representation of angling, *c.* 2000 B.C. From "Fishing from the Earliest Times."

The present volume would have gained by a wider reference to evidence derived from ethnological sources, and some of the problems with which Mr. Radcliffe deals so interestingly might have been more convincingly attacked or solved. Mr. Radcliffe takes especial delight in tracing the earliest references to various fishing-appliances. [See Figs. 1 and 2 here reproduced by the courtesy of the publishers.] To Martial he assigns the first mention of the jointed rod (*crescens harundo*), and of fishing with a fly; but to Ælian the first definite reference to the use of an *artificial* fly. In dealing with the latter, he appears to be convinced that the artificial fly of those days was an imitation, as close as possible, of a *natural* fly; but this view does not seem to be borne out by Ælian's description, which rather suggests the reverse, *i.e.* a type of lure which was a novelty to the fish, which were attracted by its unusual gaudiness. Aristotle is given credit as the first "scale-reader" in estimating the age of fishes. There seems to be a zoological confusion when Mr. Radcliffe uses evidence from two passages, one of which refers to the *scales* of fish which afforded an indication of age, while the other relates to the growth indications upon the *shell* of a Murex (a mollusc). But zoological differentiation is scarcely Mr. Radcliffe's strong point, and he apparently is convinced that dolphins are to be classed with the fishes (pp. 91, 92, 95, 165, 450, etc.), and this in spite of the fact that Aristotle, whom he quotes, recognised essential differences between fish and cetacean mammals. The plate opposite p. 180 is described as illustrating a "pattern of Torpedo fish"; but the three fishes represented clearly belong to three distinct varieties, all of them *bony* fishes, whereas the Torpedo fish (a kind of ray) belongs to the group of *cartilaginous* fishes. Again, on p. 414, he includes shell-fish among the fishes prohibited by Moses, without any covering comment. These "termino-zoological inexactitudes" tend somewhat to obscure the scientific status of the book.

A time-honoured controversy is revived and reviewed in detail in chapter 2, where the author deals with the various interpretations of the function of the ox-horn (κέρας βοὸς ἀγραύλοιο) referred to in the "Odyssey"

(xii. 251 ff.) and "Iliad" (xxiv. 80 ff.) in connexion with similes derived from fishing processes. The very varied theories are quoted and evaluated with skill, and the author himself inclines toward the suggestion of C. E. Haskins, namely, that the κέρας was an artificial bait of horn. This controversy has been carried on in the pages of the *Times* Literary Supplement, in reviews of the book, and in letters arising therefrom. The whole discussion, however, leaves one unconvinced and still wondering. Since the controversy still remains "fluid," I am tempted to offer yet another possible solution, to take its chance with those previously offered. Line-fishers on the coast of Western Ireland employ a very simple and ingenious contrivance to overcome the difficulty which arises from their hooks becoming entangled in seaweed, when fishing is pursued in rock-studded waters. It is desired to sink the baited hook below the level of the weed layer, and the problem is to pass it through the tangled and entangling mass. To achieve this, at a short distance above the hook there is attached to the line a crab's claw, which serves as a stop. Still farther up the line a weight (or sinker) of lead or stone is fastened, and between the stop and the weight an empty carapace of a crab is loosely threaded upon the line, so that it can slide along the latter between the sinker and the stop. When the line is cast out by the fisherman, the weight descends first, dragging after it the line; the water-resistance causes the bell-like carapace to slip along the line as far as the stop, so that it covers and protects the baited hook as it is carried downward through the weed stratum. Since the carapace is very light it probably floats away from and uncovers the bait when the line becomes stationary at the desired depth. Similarly, as the line is drawn in the resistance of the water drives the bell down over the hook and again protects it on the upward journey. Now, substitute a selected bell-shaped ox-horn for the crab's carapace and a slightly more efficient form of this apparatus is devised, which should serve the same purpose admirably.

FIG. 2.—The happy fisherman, attributed to the artist Chachrylion. From "Fishing from the Earliest Times."

The merit, if any, of my suggestion is derived from the following facts, (1) that the apparatus which affords a seeming clue to the function of the κέρας is an actual one still in practical use locally, and is very possibly a survival from an ancient type formerly far more widely employed; (2) that the much-debated "resounding splash" (cf. στονάχησε δὲ λίμνη in the Iliad passage) is plausible as a description of the effect produced by casting such an apparatus into the sea; (3) that it is consistent with fishing from a headland on a rocky and weedy coast such as, I believe, is characteristic of southern Italy and of the region lying between Samos and Imbros, the areas to which Homer's two similes are applied; (4) that it conforms with the picturesque description of the dive of Iris when she "sped to the bottom like a weight of lead, that mounted on the horn of a field-ox goeth down, bearing death to the ravening fishes"; (5) that the κέρας βοὸς ἀγραύλοιο which some commentators aver must imply the *whole* horn, and not merely an object made of horn, would, for the purpose I have suggested, have been practically entire, so that the hook could be withdrawn into its protecting cavity. A small hole drilled in the apex (through which to pass the line) would be the only essential modification required. The expression "mounted *on* the horn" alone offers some difficulty; "near" or "with" instead of "on" would certainly have added weight to my suggestion.

The problems suggested by or dealt with in this book are numerous, and Greek, Roman, Egyptian, Assyrian, Jewish, and Chinese fishing methods and fishing lore

all receive detailed and careful treatment. The author has brought to bear upon his task the experience of a practical and enthusiastic angler, and the zest of a keen student. While he realises the more serious aspects of his theme, he has dealt kindly by the general reader and writes in a light-hearted, attractive, and unpedantic manner. In this way he should be instrumental in developing a wider interest in and stimulating further research into the history of one of the oldest industries, and has given us the story of progress from a humble and despised craft to a popular and respected art.

HENRY BALFOUR.

The Metallurgy of Iron and Steel.

(1) *Engineering Steels.* By Dr. L. Aitchison. (Reconstructive Technical Series.) Pp. xxxi+348+48 plates. (London: Macdonald and Evans, 1921.) 25*s.* net.

(2) *The Case-Hardening of Steel: An Illustrated Exposition of the Changes in Structure and Properties induced in Steels by Cementation and Allied Processes.* By H. Brearley. Second edition. Pp. xi+207. (London: Longmans, Green and Co., 1921.) 16*s.* net.

(3) *Iron-Founding.* By B. Whiteley. (Pitman's Common Commodities and Industries.) Pp. 131. (London: Sir I. Pitman and Sons, Ltd., 1921.) 3*s.* net.

(1) THE advance of metallurgy in recent years has placed at the disposal of the engineer a wide range of new materials, including alloy steels which so far surpass the older, plain carbon steels in strength and toughness as to constitute a new class of metals. In the face of such diversity the engineer finds difficulty in selecting the most suitable material for a given purpose, and is not in a position to judge between the products offered by manufacturers, or recommended by specialists. There are in existence many excellent memoirs and a few books on the subject, but they are written for the metallurgist, and assume a technical knowledge that lies outside the usual field of study of the engineer. It is highly desirable that the user of a metal should understand its properties as well as the maker, and Dr. Aitchison has made the attempt, largely successful, to describe the steels now available for engineering purposes, without assuming a knowledge of chemistry or metallurgy.

The title of Dr. Aitchison's book must be interpreted in a rather restricted sense. The engineer is interested in such steels as those used for ship and boiler plates, rails, and girders, but he will find little in reference to them, the work being mainly concerned with steels required by the automobile and aircraft industries. It is these steels of high tensile strength, often required to withstand severe alternating stresses, that present the greatest difficulties of specification and testing, and it is very necessary that the information regarding them should be collected and placed clearly before the engineering user, as has been done here. There is a very brief account of methods of manufacture, sufficing to indicate the distinction between various classes of steel, and a discussion of ingot structure, so far as is required to explain the possible sources of defects in forgings.

It is probably on account of the limitation mentioned above that only piping steel is described, and the subject of blowholes is not mentioned. Steel castings are omitted entirely, although of great interest to the engineer who uses high tensile steel forgings for other parts of his machine. The desire to avoid chemical and metallurgical difficulties leads to a somewhat excessive simplification of the chapter on heat treatment, and the author's account of hardening and his explanation of the critical points is rather misleading, although not likely to cause misunderstanding of the practical instructions. It should be said that the style is easy and readable throughout.

The subject of mechanical testing is well treated, proper attention being given to the determination of the fatigue range and its relation to the other measurements usually made in the testing laboratory. Much of the experimental material in this chapter is taken from the author's reports to the Aeronautical Research Committee. His conclusions may not always be accepted, but the importance of the subject is rightly emphasised, and the descriptions of fatigue tests and the short accounts of other special methods of testing are valuable. There are very few references to original sources, but a full bibliography of papers relating to the determination of hardness is given.

The alloy steels are considered in detail, the properties of each steel, as modified by different heat treatments, being shown by means of diagrams similar to those published by the Automobile Steel Research Committee; these diagrams provide a useful guide to the characteristics of the various classes of steels. Case-hardening and cold-working are other subjects dealt with.

The book is very well printed and illustrated, many of the best plates being selected from Mr. Brearley's works, while others show special types of testing machines. The whole subject of the relative value of tests for steels of this class is in a state of flux, and an authoritative statement is not yet to be expected, but Dr. Aitchison has made a good beginning, and his efforts will be welcomed by engineers.

(2) The first edition of Mr. Brearley's book on case-hardening was published in 1914, and it is an indication

of its trustworthy character that scarcely any statement contained in it has had to be withdrawn in the preparation of the new edition. The subject-matter has been widened by the inclusion of further particulars concerning alloy steels of the class frequently employed in automobile construction, and by the addition of sections on specifications, in regard to which the author expresses decided opinions, based on a wide experience. The treatise is of more general interest to the metallurgist than might be assumed from its title, since the description of the materials and processes of case-hardening and of the defects that may occur in case-hardened objects, involves the discussion of many other points of importance in the treatment and use of steel. On all these subjects, the advice given is sound and admirably clear in its expression. Only two minor points have been noted for criticism. There is no mention of nichrome carburising boxes, although these are now frequently used, and justify by their long life the increased cost. Plating with copper, as a means of local protection against carburisation, is still spoken of as unsatisfactory, although it has been practised with great success in the construction of aero-engine parts.

(3) The third work on our list is an elementary handbook on iron-founding. It contains a simple description of foundry methods, and the illustrations include a series of photographs of the mould for a gas-engine cylinder at various stages. Moulding is considered much more fully than melting, and the book is well adapted to give a general idea of the processes used in preparing moulds, and of the organisation of a foundry. The theoretical side is weak, and some very erroneous statements as to fuel and thermochemistry would have been better omitted. The printing and illustrations are good. C. H. DESCH.

The Snakes of Ceylon.

Ophidia Toprobanica, or The Snakes of Ceylon. By Col. Frank Wall. Pp. xxii+581+1 map. (Colombo: Colombo Museum, 1921.)

A GOOD deal has been written on the subject of the snakes of Ceylon. Thus Günther's "Reptiles of British India" (1864), and Boulenger's "Fauna of British India—Reptiles and Batrachians" (1890), both include descriptions, and in the case of the former work, remarks on the habits of many of the snakes inhabiting Ceylon. There is also the "Snakes of Ceylon" by Abercromby, a small popular treatise which appeared in 1910. Except for the last-named work, which is very incomplete, there is, however, no book which deals solely with the snakes of Ceylon, apart from those inhabiting India, and Col. Wall, an enthusiastic naturalist and specialist on Indian snakes, in producing the volume under review has succeeded in filling a long-felt want.

The author in his work gives an account of the marine snakes which may be met with around the shores, as well as the terrestrial forms. A full description is given of every snake, and the determination of the genera and species is often facilitated by useful, if somewhat unscientific, keys. Except when dealing with the sea-snakes, Col. Wall has in most cases adopted the nomenclature used in Boulenger's Catalogue of the British Museum. Sometimes the generic and specific names have been altered. It is impossible without going thoroughly into the various contested points to say whether the author is in every case justified in departing from Boulenger's classification, although he occasionally appears to have good reasons for so doing. We are not, however, always inspired with confidence in Col. Wall's judgment. Thus "until I am satisfied of their specific unity I prefer to regard them as distinct species" is the dogmatic reason he gives when advocating specific distinction for certain forms of Kraits, held by Boulenger, in spite of their distinctive coloration, to be only geographical varieties of the same species.

A feature of the book is the very full account given of the habits of the snakes. The author has had practical experience of the reptiles in their native haunts, and his descriptions of their feeding and breeding habits add greatly to the value of the work. There are also some interesting remarks on the subject of distribution. Many snakes inhabiting upland regions have a very restricted habitat, neither ascending nor descending beyond certain limits. The elevated ranges and peaks, where the lower slopes merge into the low country, are just as effectually isolated as if they were surrounded by the sea.

Much space is devoted to the subject of snake-bite, for the benefit of the medical practitioner, and a number of illustrative cases from the records of various doctors are given. E. G. B.

Japanese Social and Economic Life.

The Foundations of Japan: Notes made during Journeys of 6000 Miles in the Rural Districts as a Basis for a Sounder Knowledge of the Japanese People. By J. W. Robertson Scott. Pp. xxv+446+plates. (London: J. Murray, 1922.) 24*s*. net.

THIS is an eminently readable book, giving not only the familiar glimpses into superficial Japanese life, but also treating of the economic life of

the nation in a really profound manner. The author spent four and a half years travelling through the country, studying the habits and thoughts of the men and women of the countryside, who were trained under rural schoolmasters and village elders and are living their life under the potent sway of long-established tradition. The modern industrial developments of factory life are also depicted with a sure hand, and where there is much to praise there is also much to condemn. For example, the conditions under which silk-factory girls work are little short of slavery, and would be impossible in English-speaking countries. On these and other deeper aspects of Japanese life the author evidently speaks with knowledge. With real sympathy and honesty he describes the present-day sociological conditions which rule among the great majority of Japanese. As he himself says, he went to Japan to see the countrymen.

"The Japanese whom most of the world knows are townified, sometimes Americanised or Europeanised, and, as often as not, elaborately educated. They are frequently remarkable men. They stand for a great deal in modern Japan. But their untownified countrymen . . . What is their health of mind and body? By what social and moral principles are they swayed? To what extent are they adequate to the demand that is made and is likely to be made upon them?"

Such are some of the questions which Mr. Scott sets himself to answer. This he does by describing his wanderings in various provinces, touching upon all kinds of Japanese customs as they come before him. The result is in many cases a curious mosaic of random thoughts, greatly satisfying to one who has lived in Japan, but probably not a little confusing to one who has never been there and is reading for enlightenment. In other chapters, however, there is a sustained and serious discussion of some broad aspect of Japanese life. In all cases the author writes with a freshness and accuracy which bespeak a full knowledge and a discriminating judgment.

Dealing as it does with the facts at the basis of human life, the book is aptly called the "Foundations of Japan." From this point of view the book is a real addition to ethnological literature, and is worthy of commendation in the pages of NATURE. For the more serious student of industrial economy there are some interesting appendices with instructive statistics; and well-chosen drawings and photographs elucidate many of the questions discussed. Among the subjects treated at considerable length are the cultivation of rice, the whole process of sericulture, the problem of labour, and the education of boys and girls. In conclusion it may be said that Mr. Scott has the gift of a true teller of stories, many of which show forth in a graphic way some characteristic traits of our Eastern Allies.

Hull and the East Riding.

Handbook to Hull and the East Riding of Yorkshire: Prepared for the Members of the British Association for the Advancement of Science on the Occasion of their Visit to Hull, in September 1922. Edited by T. Sheppard. Pp. viii+532. (London and Hull: A. Brown and Sons, Ltd., 1922.) 5*s*.

THE ideal handbook in connexion with the annual visits of the British Association has yet to be written, but it would be unfair if we withheld the full meed to the editor and sub-committee who have produced this interesting publication. It approaches nearer to our ideal than that issued at any previous meeting; so far as possible technicalities have been avoided, for the work is not intended for the expert, who already knows the special works and articles relating to the different subjects treated of. It is essentially a guide for the average member who wishes to learn something of the history, archæology, antiquities, folk-lore, geology, natural history, and economics of the town and district in which the parliament of science has recently been held.

After a brief account of the evolution and growth of Hull, we pass on to short accounts of its past history and antiquity, its rise and progress, places of interest, Hull coins and tokens, its charters, etc. The various prehistoric remains of East Yorkshire are briefly described and illustrated, and interesting chapters are devoted to the Romans, Anglo-Saxons, and Danes in this division of the county. The Rev. Canon A. N. Cooper contributes a well-illustrated chapter on East Riding churches, and Mr. John Nicholson one on East Riding place-names. There are further sections treating of the charities, engineering and shipbuilding, education, agriculture in the East Riding, while the geology and lost towns of the Humber receive very full treatment at the hands of the editor.

Nearly three hundred pages are devoted to the description of the fauna and flora, and in spite of the fact that some of the writers have not been able to depart from the useless local list method of treatment, the various contributors have handled their sections most ably. An outstanding feature is Mr. John W. Taylor's excellent account of the land and freshwater mollusca. The weakest section is undoubtedly that on the crustacea, which is unfortunate, as much good work has been done on the non-marine forms.

Apart from its value and usefulness to the visitor to Hull, this work will fulfil a double service if it serves

to show the citizens of Hull the many points of interest their city possesses, and of which they are the trustees.

The wealth of illustrations considerably adds to the interest of this work. Future compilers of the British Association local handbook will do well to study carefully the Hull model. W. E. C.

Our Bookshelf.

The Biology of the Seashore. By F. W. Flattely and C. L. Walton. Pp. xvi + 336 + 16 plates. (London: Sidgwick and Jackson, Ltd., 1922.) 16*s.* net.

THE study of zoology from the ecological standpoint has made rapid strides in America under the energetic leadership of Dr. Adams and Dr. Shelford, and there has been a steady output of text-books and popular books on Nature study written from this point of view. In this country, zoological ecology has received very little attention, and we welcome, therefore, if only on these grounds, this excellent work on the biology of the seashore. As the authors point out, their book is not intended to supersede but to supplement previous works which have been written on classificatory and morphological lines. In fact, they demand a previous knowledge of classification and external morphology in those who use their work. Given this the authors have directed special attention to functional biology and to the adaptations which organisms present to marine life in all its phases.

The book is an exhaustive summary of the known facts of marine biology from the ecological point of view, and reveals a wide knowledge of the literature of the subject. The illustrations are good and adequate, and the advice given on the methods of ecological research should be most useful to students. The authors, however, have not been content merely to summarise known facts. The book bristles with suggestions for research and further inquiry, and in this respect is most stimulating. It should be in the hands of all students of marine biology. With its help more real knowledge of life in the sea will be obtained than from any other text-book we know. It is not enough to know the mere population of the sea; some knowledge of the laws governing life there, and of the actions and interactions of organism and environment is vastly more interesting and stimulating, and the work under notice supplies the right kind of guidance in this inspiring field of study.

Catalogue of the Books, Manuscripts, Maps, and Drawings in the British Museum (Natural History). Vol. 6. Supplement: A-I. Pp. iv + 511 + 48. (London: British Museum (Natural History), 1922.) 2*l.* 15*s.*

THE Library of the British Museum of Natural History is probably one of the most complete, and certainly one of the most important, libraries of works on natural history in the world. The publication of a catalogue of its contents has been of immense service to scientific workers, who find in it a valuable guide to the literature of their subject and a wealth of bibliographical detail which is of the greatest value in settling vexed questions of priority and ensuring accuracy of reference. The first half of the supplement to the main catalogue has now been issued and serves to give some idea of the natural growth of this splendid library. Like the preceding volumes, it has been prepared by Mr. B. B. Woodward with the same meticulous care and accuracy, and includes as before the results of much bibliographical research by the author and Mr. C. D. Sherborn. The 48 pages of "Addenda and Corrigenda" to the main catalogue consist almost entirely of additional bibliographical information which has accumulated since the catalogue was published.

The expenditure of public money on the publication of a catalogue of this kind is more than justified by its extreme value and usefulness, though it is a pity that so valuable a work as this supplement should have been sent out in a paper cover. For its own value and for the sake of uniformity it is worth a binding similar to its predecessors. Scientific workers are grateful to Mr. Woodward and to the trustees of the British Museum for having made the resources of their library known in this readily accessible form.

Obras completas y correspondencia científica de Florentino Ameghino. Volumen 3. La Antigüedad del Hombre en el Plata. Dirigida por Alfredo J. Torcelli. Pp. 821. (La Plata: Taller de Impresiones Oficiales, 1915.) n.p.

THE third volume of the handsome collected edition of the late Florentino Ameghino's geological and palæontological works now being issued by the government of the province of Buenos Aires, is a reprint of his treatise on the antiquity of man in La Plata originally published in 1880. Francisco Moreno had then just founded the Anthropological and Archæological Museum at Buenos Aires (afterwards removed to La Plata), and Ameghino himself was studying with Henri Gervais in Paris, where he exhibited part of his collection at the Universal Exposition. The author was thus well furnished with materials, and had unusual opportunities of making himself acquainted with the latest advances in the subject of the antiquity of man. While describing the results of his own researches, he therefore took the opportunity of making many references to European and North American work which were illuminating. His volume is a most exhaustive discussion of the remains of the handiwork of prehistoric man discovered in Argentina, illustrated by twenty-five large plates. Of the skeleton of man himself no important fragments had at that time been found. The geological observations are particularly valuable and interesting, and Ameghino seems to make it quite clear for the first time that the man of the pampas was a contemporary of the extinct glyptodonts or giant armadillos, and actually used their large bony carapaces as roofs for his lowly habitations. Although naturally out-of-date, the whole treatise is a valuable record of facts and observations, in which the reprint will stimulate renewed interest. A. S. W.

Le Pôle Sud: Histoire des voyages antarctiques. Par J. Rouch. Pp. 249. (Paris: Ernest Flammarion, 1921.) 7 francs net.

M. ROUCH was one of the officers of the *Pourquoi Pas?* in Dr. Charcot's second Antarctic expedition, and familiarity with the conditions of navigation and the privations of wintering in the Far South has given him

a great advantage in dealing with the history of exploration in the South Polar regions. With the space at his disposal no one could have done better than M. Rouch in setting forth with equal detail all the outstanding Antarctic voyages from that of Cook in the *Resolution* to that of Shackleton in the *Endurance*. Except for a very few slips in the spelling of names (*Thun* instead of *Chun* on the *Valdivia* is the only serious one) the accuracy of the work is quite remarkable, and the facts regarding the various expeditions have obviously been selected from the original narratives.

The style is lively and sympathetic but concise and sailorly. M. Rouch holds all explorers as his brothers and there is a delightful air of *cameraderie* in his treatment of the aspirations and achievements of British, French, Russian, American, Swedish, Norwegian, and German explorers. It is refreshing to find this fine French sailor giving credit impartially to his German rivals and his French colleagues, and with an almost British self-criticism touching more frankly on the little shortcomings of his fellow-countrymen than on those of foreigners.

Perhaps the author's imagination has assisted a little in describing the details of Scott's last expedition; but if he here allows dramatic truth to prevail over verbal accuracy it is in excess of sympathy.

The numerous illustrations are excellent as showing Antarctic conditions, but they obviously refer only to the author's own section of the region. H. R. M.

Mineral Land Surveying. By Dr. J. Underhill. Third edition, revised. Pp. viii+237+3 plates. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1922.) 17*s.* 6*d.* net.

DR. UNDERHILL'S book describes the methods in use for the survey of the mineral lands in the western portion of the United States. It should certainly be in the possession of all surveyors who intend to proceed there; but only the first three chapters are likely to be of much service to mine surveyors in England. In chapter 1, on direct solar observation, the method of obtaining the true meridian by single observations on the sun is clearly and fully explained, with the aid of several worked examples, after the derivation of the formula employed has been given. The method of obtaining latitude by solar observation is also briefly described. Chapter 2 describes the Shattuck Solar Attachment, the Burt Solar Attachment, and the Berger and Saegmuller Solars and their use for finding true meridian and latitude. Of these, the Shattuck Solar Attachment appears to find most favour with the author, who states that he has obtained perfect checks on this instrument by direct observation of the sun. Chapter 3 is a useful account of traversing and measurements, including stadia measurements. Other chapters deal with location surveys, including calculation of areas by the double meridian distance method, patent surveys, patent field notes, Land Office and Records, and the examination for commissions as United States Mineral Surveyor with typical questions and solutions. The appendix includes extracts from the Manual of Instructions for the Survey of the Mineral Lands of the United States.

L'Océanographie. Par Prof. J. Thoulet. (*Science et Civilisation: Collection d'exposés synthétiques du savoir humain.*) Pp. ix+287. (Paris: Gauthier-Villars et Cie, 1922.) 9 francs.

THIS book is one of a series which offers a general account of modern scientific research in its relations to civilisation: it is written in a pleasant, continuous manner and, on the whole, is a very good exposition of the main results of physical oceanography. It follows the line of treatment which appears now to have become classical since the publication of Krümmell's big book in 1907–11: an account of the bottom of the ocean and its deposits; the physics and chemistry of sea water; waves and tides; and the formation of ice. The ocean in its relation to life and the development of the foreshore and coast-line are scarcely touched. The theory of the tides is dealt with very slightly, and the statement is made that all tidal problems have been elucidated by Airy's "théorie des ondulations": quite lately, of course, the dynamical theory of the tides has been almost transformed. There is no account of the methods of prediction.

In such a work as this figures and charts are indispensable, yet the book under review only contains eight text-figures and these are rather difficult diagrams. It can be read with advantage and by the non-professional reader only with constant reference to a good atlas of physical geography, and there is no such work in existence which includes all the recent investigations of marine currents and drifts. J. J.

The Misuse of Mind: A Study of Bergson's Attack on Intellectualism. By Karin Stephen. (International Library of Psychology, Philosophy, and Scientific Method.) Pp. 107. (London: Kegan Paul and Co., Ltd.; New York: Harcourt, Brace and Co., Inc., 1922.) 6*s.* 6*d.* net.

THIS important study of Bergson's philosophy is not an attempt to epitomise or expound the principle, the method, or the particular content. It concentrates on an attempt to understand what is generally rejected as unintelligible—the attack on intellectualism. In Bergson's view the tradition of philosophy is all wrong and must be broken with; philosophical knowledge can be obtained only by "a reversal of the usual work of the intellect." The author gives us in three chapters first a criticism of "explanation," then a criticism of "fact," both with reference to Bergson's theory of change, and in a final chapter shows how light is thrown on the problem by his theory of the relation of matter to memory.

Les Sciences et le Pluralisme. Par J.-H. Rosny, aîné. (Nouvelle Collection Scientifique.) Pp. iv+219. (Paris: Félix Alcan, 1922.) 8 francs net.

M. ROSNY'S thesis is that "pour retrouver l'uniforme nous sommes contraints de nous rabattre sur des substances ou des énergies hypothétiques. En fin de compte, l'homogène que nous trouvons est subi ou créé par le moi, mais non strictement *donné par les choses.*" The volume contains a lucid discussion of the most recent theories in mathematics and physics.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Mersenne's Numbers.

IN my presidential address to Section A of the British Association, reprinted in NATURE (September 16), I stated that 137 was the least value of n for which the prime or composite character of $2^n - 1$ was still undecided. Mr. W. W. Rouse Ball has pointed out to me that this is incorrect, as $2^{137} - 1$ has been shown to be composite by M. A. Gérardin (*Comptes rendus du Congrès des Sociétés Savantes*, 1920, pp. 53-55). The result is quoted in *The American Mathematical Monthly*, vol. 28, 1921, p. 380. The number 139 should therefore be substituted for 137 wherever it occurs in my address.

The authorities on which I relied were Prof. L. E. Dickson's "History of the Theory of Numbers" (vol. 1, Washington, 1919) and the seventh edition of Mr. Rouse Ball's "Mathematical Recreations" (1917, now superseded by the tenth). My quotation from Mr. Rouse Ball was taken, as I stated, from a pamphlet written thirty years ago, and is, of course, not to be interpreted as an expression of his present view.

G. H. HARDY.

New College, Oxford, October 4.

Animal Mechanism.

THE notion that the legs of animals behave as pendulums is ascribed to the brothers Weber. I can find no indication that the notion was more than a general one, and, in the general sense, when pointed out, it is obvious to a student of dynamics, for legs have inertia and weight and dynamics is reasonably near to the truth.

A better view may arise from the supposition that animals may be regarded as dynamical systems with many natural modes and frequencies, and that animals adapt their methods of locomotion and other actions to suit these fundamental characteristics. As examples, we have the lounging gait of very tall men and the apparently energetic step of short men. The tripping, half running step of women and children is also in point. Apart from mere legs the moment of inertia about the feet must be important, as may be seen in the stately carriage of quite short women in the East when carrying water vessels on the head. Sir George Greenhill has given several examples of this in his notes on dynamics, among them being interesting examples of the carrying of soldiers' kit.

A further point of interest arises in regarding legs a little closely, for they are not simple but multiple pendulums with more than one natural mode. When a horse or man is walking the leg appears to vibrate in the slowest mode of the pendulum and the joints are or appear to be on one side of the vertical. In the running gait, however, the thigh points forward while the lower parts point backwards. Probably the "reason" why a horse's forelegs are more flexible than the hind legs is to make him nimble in balance and steering; a horse could not stumble with his stiff hind legs.

The dynamics of locomotion is of interest to the student of engine balancing, for in the natural gaits of man and horse there is a utilisation of balancing principles. In man the right leg moves forward while the right arm moves backward, in the horse the right legs are always moving in opposition and similarly the left legs, of course. This holds for the walk, the trot, and the gallop, all natural modes. In the amble, an artificial stride due to the trainer, the legs on either side are in phase and an ungainly motion results, though it is comfortable for the rider. This amble stride is natural to the giraffe, but the latter has a long neck to give it poise. The balancing view of animal locomotion may be realised at once by any one who will try to run with stiff arms or will try to walk with his arms tucked up in the running posture. The runner is compelled by dynamics to move his legs in a quicker mode than when walking. His arms are so jointed that he cannot alter their type of vibration, and he is therefore compelled to reduce their inertia in order that they may oscillate in time with his legs. The balance from the engineer's point of view is imperfect, and thus stresses are imposed in the trunk. Hence sprinters are well-bodied men and horses need girth for speed. As a final example of these facts, let any one try to run to the station with a heavy suit-case in his hand. Porters usually carry such things on their shoulders and stride rather slowly.

There is a further point of interest in connexion with the viscera. If dynamics is true, the various internal organs have inertia and their attachments have elasticity; thus they must possess natural frequencies. This being so, they must be subject more or less to the phenomena of resonance. Is sea-sickness, subjective agencies apart, to be explained in this way? Some people before embarking have a copious meal, others pin their faith and hope to a single bottle of stout, while yet others proceed fasting. Is this a phase of dynamical tuning? In 1914 I read a short paper on the dynamics of the human foot at the British Medical Association's summer meeting. The outcome of the discussion was that tonicity was more potent than mechanics, or, in other words, living tissue may vary in its properties on account of tone or debility to a degree which will exceed the influence of configuration. The contention would be that while astringents or food may alter the effects of a sea voyage, the action is due to dynamical effects; the inertia of the stomach or the stiffness of its suspension is varied—opiates and such like are here excluded.

A medical writer of some eminence recently advocated walking because "Nature has ordained that the finest exercise of all is that which she bestows." While this is reminiscent of Heine's "Harzreise," the greenness of grass and the length of a donkey's ears, there is in it matter for reflection. Motor car designers, led by Dr. Lanchester, have found that the most comfortable predominant natural frequency of a motor car is between 80 and 100 per minute; it is a curious coincidence that this is also the frequency of the ordinary walking step. Has the human system, enforced by dynamics to walk in a certain rhythm, acquired an internal system and a nervous organisation to meet this rhythm? It is worthy of note that in certain cars several dogs and children have been actually and violently sick and in other cars sprung to vibrate with a different natural period they are immune. Shall we, disagreeing with Shylock, say, "It is not their humour, but their natural frequency"?

H. S. ROWELL,
Director of Research,
Research Association of British Motor and Allied Manufacturers.

15 Bolton Road, W.4, September 20.

Vegetable Rennet.

I HAVE been endeavouring to make a list of plants—leaves, flowers, seeds, etc.—used in various countries for coagulating milk in place of rennet, obtained from the stomachs of young animals; and I shall be glad to learn of any additions that might be made to the following list:—*Galium verum, Withania coagulans, Ficus Carica, Cynara cardunculus, Cynara scolymus, Carduus nutans, Cnicus benedictus, Drosera peltata, Datura Stramonium, Pisum sativum, Lupinus hirsutus, Ricinus hirsutus, Pinguicula vulgaris, Leucas cephalotes, Crotalaria Burhia, Rhazya stricta* and *Streblus asper*.

With regard to some of the plants named above, I would note that the references are not very clear as to their use for milk coagulation. Any information as to plants used in former days or at the present time would be welcome and useful. A Hindu, also an orthodox Jew, cannot touch, I understand, a milk product that has been coagulated by rennet obtained from a calf's stomach, and must therefore use a vegetable coagulant; and I believe that there are other races in other parts of the world which use vegetable coagulants. So far as I am aware, an approximately complete list of plants used in various parts of the world for coagulating milk does not exist, and where a reference is found, details given are scanty as to part of plant used, its preparation, and method of use. R. HEDGER WALLACE.

4 East Grove, Cardiff, September 20.

A Question of Nomenclature.

IN his notice of Mr. S. Q. Hayes's "Switching Equipment for Power Control" in NATURE of September 16, p. 374, your reviewer, commenting on current Americanese, says: "Electrical engineers talked about 'omnibus bars' thirty years ago, it then became 'bus bars,' and now apparently it has become 'busses.'" Webster, who may be considered as an authority on the language of that great nation, defines a buss as "a kiss; a rude or playful kiss; a smack," and quotes Herrick to the effect that:

> Kissing and bussing differ both in this,
> We buss our wantons, but our wives we kiss.

So that although in both "bus bars" and "busses" there is intimate contact and at times electricity passes, it can scarcely be said that the two terms are synonymous. Nor can it be said that the introduction of such terms into electrical engineering is to be commended. F. H. MASTERS.

Capillarity.

IN a letter on capillarity in NATURE for September 16, p. 377, Mr. Wilson Taylor shows how difficult it is to account on physical grounds for the phenomena exhibited by liquid films.

It may not be out of place in the circumstances to refer to Irving Langmuir's views on this subject, given by him in a paper on "The Constitution and Fundamental Properties of Solids and Liquids. II. Liquids" (Am. Chem. Soc., vol. xxxix., September 1917, p. 1852). Langmuir cites a few of the cases in which the forces between the molecules have been considered to be radial forces which vary solely as a function of the distance between molecules. In all these cases the investigator has considered the phenomena to be physical in nature. He then goes on to remark: "The chemist, on the other hand, in studying the properties of matter, usually employs totally different methods. He is often most interested in the qualitative aspects of the problem, and the quantitative relationships are usually limited to those deducible from the law of multiple combining proportions, the law of mass action, or the principles of thermodynamics. When the chemist does consider the forces acting between atoms and molecules, he does not look upon these as forces of attraction between the centres of the molecules, but he thinks rather of the specific nature of the atoms forming the molecules and the manner in which these atoms are already combined with each other. He thinks of molecules as complex structures, the different portions of which can act entirely differently towards any given reagent. Furthermore, he considers that the forces involved in chemical changes have a range of action which is usually much less than the diameter of a molecule, and perhaps even less than that of an atom."

What has been termed the Classical Theory of surface forces has proved useful in its day; but it unfortunately ignores *chemical affinity*.

R. M. DEELEY.

Tintagil, Kew Gardens Road, Kew, Surrey,
September 15.

Lead and Animal Life.

DR. GARRETT'S communication in NATURE of September 16, p. 380, on the effect of a lead salt on Lepidopterous larvæ, is particularly interesting to one who has been working on an allied subject. Recent investigations of my own on the fauna of lead-polluted streams in North Cardiganshire, as reported at the Hull meeting of the British Association, point to the presence of dissolved lead-salts in these rivers as distinctly inimical to the aquatic population, in particular to the larvæ of certain insect-groups, such as Trichoptera, which are normally non-existent in these streams, though well represented in their neighbours.

The case of fattening of Weardale sheep on lead-polluted pastures may perhaps provide a parallel; while it is quite possible that small doses of lead may have a tonic effect, cases of lead-poisoning proper among farm live-stock in general are common in certain districts (see a paper on "Plumbism in N. Cards." by E. Morgan, *Journal of U.C.W. Agricultural Dept.*, 1915), and usually the poisoning is of the type known as "chronic," the effect being slow and cumulative, as is also established in the case of lead-poisoning as an industrial disease. It would be interesting to know whether Dr. Garrett's experiments have extended over more than one generation of Lepidoptera, and whether the reproductive faculties were in any way affected. K. CARPENTER.

Department of Zoology, University College
of Wales, Aberystwyth.

Polar and Non-Polar Valency in Organic Compounds.

THERE is an increasing tendency on the part of organic chemists to apply the Berzelius dualistic theory, in a modified form, to organic compounds. In many theories of valency, individual groups are considered to be more or less electropositive or electronegative, and it is possible to arrange these groups, approximately, in a table of descending electropositive character. A difficulty which arises in examining this conception is to visualise the transference of anything less than one electron between the group and the remainder of the molecule. There appear to be at least two kinds of forces operating between atoms in a molecule, which can

be designated as polar and non-polar. The polar character of the valency in the majority of salts is definite; there is experimental evidence for the transference of electrons in these substances. The non-polar forces are particularly in evidence in the linkings of organic compounds, and it is extremely unlikely that transference takes place to an appreciable extent here. Without entering into a discussion of the nature of the non-polar forces, which may be electromagnetic, there are two explanations which may be given of the undoubted positive and negative relationships of groups in organic compounds. In the first place, there may be a partial transference of an electron between the group and the residue of the molecule, or alternately there may be a varying concentration of polar molecules in the typically non-polar substance.

I venture to put forward a plea for the consideration of this second possibility. An equilibrium may be imagined to exist between the polar and non-polar substances which will be affected by the temperature, solvent in which it is dissolved, etc. Thus, in an organic substance AX the equation,

$$\overset{-}{A}\overset{+}{X} \rightleftharpoons AX \rightleftharpoons \overset{+}{A}\overset{-}{X}$$

may represent this kind of equilibrium, and the more electronegative the group X the more will this reaction proceed to the right. In those substances where the stability of the non-polar arrangement is very great, the occurrence of both forms, $\overset{-}{A}\overset{+}{X}$ and $\overset{+}{A}\overset{-}{X}$, will be possible, and in the presence of a suitable solvent these may give rise to the respective ions. This view is in agreement with the occurrence of a group in some compounds with an electropositive, and in others with an electronegative tendency. The ease of replacement of the group X by another group will be determined by the concentrations of the polar body, the polar state being the active form of the substance. These concentrations may be so small as to escape the ordinary methods of measurement, and yet be sufficiently great to explain the velocity of the chemical action.

W. E. GARNER.
University College, Gower Street, W.C.1,
October 4.

The X-ray Structure of Potassium Cyanide.

WRITING in a contemporary (J.A.C.S., Feb. 1922), Richard M. Bozorth gives details of X-ray investigations into the crystalline structure of KCN, and corroborates the view expressed in a letter to this journal (NATURE, Aug. 11, 1921, vol. 107, p. 745) that the underlying structure is the face-centred cube. He gives 6·55 Å as the length of its edge, which agrees very well with the 6·54 Å furnished by my measurements. He goes further in that he assigns definite positions to the carbon and nitrogen atoms and questions the opinion, expressed by Langmuir, that these constituent atoms of the CN radicle have a common outer electron shell.

Bozorth's conclusions are, to a certain extent, based on the assumption that the relative intensities of the spectra would fall off in a normal manner if the structure were quite like that of NaCl, that is, if the carbon and nitrogen atoms formed a single cluster of electrons which occupied the same position in the KCN structure as the chlorine atom does in NaCl. He publishes no numbers representing the observed intensities, but gives 100 : 10 : 3 as the relative values of the [100], [200], and [300] reflections that would be required to satisfy the requirements of his particular structure. My own measurements gave 16-17 as the relative value to be assigned to the [200] reflection, and the corresponding figure for NaCl is 20. Now the fact that KCN has a lower fusing-point than NaCl suggests that even at ordinary temperatures the heat vibrations are of unusual amplitude, and this in itself affords a ready explanation of the fact that the intensities of the spectra die away more rapidly than is normally the case. The probable electron distribution in a composite CN radicle is another important factor which would cause the normal sequence to fall off rapidly.

Bozorth gives 1·15 Å as the distance between the centres of the carbon and nitrogen atoms, and 3·0 Å as the distance between either of these and the potassium atom. He treats the carbon and nitrogen atoms as though they were of the same size, but he does not state whether or not the internuclei distance is to be taken also as the effective diameter. In one case his figures would give 4·85 Å as the diameter of the potassium atom compared with 4·15 Å, which represents, probably to within 0·03 Å, its value in the other ionised salts in which it occurs (W. L. Bragg, *Phil. Mag.*, Aug. 1920). If, on the other hand, 4·15 Å be accepted as its diameter in KCN—and measurements on NaCN justify this procedure—then Bozorth's figures would give 1·85 Å as the effective diameters of both carbon and nitrogen; W. L. Bragg's values are 1·54 Å and 1·30 Å respectively.

Fortunately, there is outside evidence which bears directly on this question. From viscosity measurements A. O. Rankine has found (Proc. Roy. Soc., July 1921) that the C_2N_2 molecule behaves in collision like two overlapping hard spheres, each having the size of a bromine atom. The diameter of the bromine atom is 2·38 Å, and that of a Langmuir CN radicle, as provided by X-ray measurements, is 2·39 Å.

P. A. COOPER.
Research Dept., Royal Arsenal, Woolwich,
September 20.

Sex Change in Mollusca.

WITH reference to Dr. R. Spärck's statement (NATURE, October 7, p. 480) that the male stage in the oyster is due to the coldness of the temperature, it should be pointed out that in various hermaphrodite mollusca, such as Helix and Arion, the reason for the passage of the indifferent epithelial cell, either to oogonium or spermatogonium, is at present unknown. Older authors considered that those cells near yolk, or near a superior nutrimental radius became eggs, and that those less exposed to steady streams of nourishment became spermatocytes.

More recent work has shown that the matter is very deep-seated, and such a conclusion as the above cannot be taken as representing the real state of affairs. I have found that oocytes appear in regions of the ovotestis which are scantily provided with yolk, and that sperm cells appear in regions rich in nutriment.

Whether temperature has anything to do with this has not yet been ascertained, but experiments are now in progress, which should settle the question.

In the case of Saccocirrus it has been shown that spermatocytes caught up and enclosed in yolk cells have their metabolism so altered that they assume the appearance of oocytes, together with nucleolar extrusions characteristic of the typical oocyte.

But in Helix two epithelial cells side by side often metamorphose, one into an oogonium, another into a spermatogonium, and one seems obliged to believe that factors other than temperature or abundance of nutriment are concerned.

J. BRONTË GATENBY.
Trinity College, Dublin University,
October 7.

The Galactic System.[1]

By Dr. HARLOW SHAPLEY.

I.

THROUGHOUT the known sidereal universe there is, among material bodies, an obvious associative tendency, which we see well illustrated in meteor showers, in satellite and planetary systems, in binary stars, and in larger stellar groups such as the Pleiades. These various products of gravitational ordering are clearly but parts of still greater systems, and one of the most fascinating of astronomical studies is to attempt to seek out the structure of an all-inclusive sidereal organisation.

It is proposed in this communication to discuss the structure and extent of the sidereal system as indicated by recent studies of stellar clusters and variable stars. My own observational investigations of these objects, and the deductions based upon them, have been mainly published in Contributions and Communications of the Mount Wilson Observatory [1] from 1914 to 1918. The present discussion is made in the light of criticisms and numerous tests to which the conclusions have been subjected during the past four or five years.

It appears that we have three principal types of celestial objects to consider—the diffuse nebulæ, the stars, and the nebulæ of the spiral family. The first two are generally thought to be related as parent and offspring. The stars, having formed, as we think, out of nebulous pre-stellar states, are, apparently, largely organised into groups, a common, possibly prevailing form being the globular cluster. It is from combinations of these clusters that I believe our galactic system has developed.[2] From the work on clusters there can be little doubt of the enormous mass and dimensions of the galactic system as compared with clusters and nebulæ. Its flat form and heterogeneity, its content of numerous fragmentary systems (open clusters, wide binaries, spectrally-similar groups) of apparently different ages and separate origins, and its control over the motions of the clusters and near-by spirals, have led me for some years to advocate the hypothesis that the Galaxy is a growing composite of disintegrating minor systems. The Galaxy appears to include all the common sidereal types, with the probable exception of most nebulæ of the spiral family. But the latter are apparently not stellar in composition, nor galactic in size. I think present evidence favours but does not establish the hypothesis that typical spiral nebulæ represent a sidereal evolution not directly connected with that of stars.

The foregoing paragraph may serve as a brief outline. Some of the details may now be considered, but, before proceeding with the discussion, I should like to point out that the proposed interpretations involve the following somewhat fundamental assumptions, if we choose to call them assumptions: (1) that gravitation directs the organisation and motions of celestial bodies; (2) that the physical laws we know are equally valid in all parts of the space with which we are familiar; (3) that the Russell-Eddington theory of stellar evolution is correct in its general features.

[1] Adapted from an Address given before the British Astronomical Association on May 31.

Certainly these three are not serious restrictions. On the first I need make no comment here. The second is the basis of our belief in the general uniformity of conditions throughout the stellar system. It insists that our stellar neighbourhood is not operated by local laws. It is a highly reasonable but necessary assumption before we can safely compare the luminosities and other properties of stars near the sun with those of stars in distant parts of the galactic system. The third assumption, the Russell-Eddington theory, is not necessary for my conclusions concerning the dimensions of the galactic system, but is essential in putting together the general scheme, and also in trying to interpret some anomalies of the spiral nebulæ. We might call the evolutionary scheme the Lane-Lockyer - Ritter - Sampson - Emden - Schwarzschild - Hertzsprung - Russell - Eddington - Jeans - Eggert theory, but Russell and Eddington have been the most important contributors to the theory in its present form.

CONCERNING STAR CLUSTERS.

Clusters of stars can be placed in two fairly distinct categories, the globular cluster, of which nearly ninety are now known, and the open or loose cluster, of which there are several hundred.

Most globular clusters (but not quite all) appear to be remarkably alike in general structure. Compared with naked-eye objects they are extremely remote; hence their stars, though apparently very faint, are actually of high intrinsic luminosity. Few stars in globular clusters are brighter than the eleventh apparent magnitude. Each globular cluster contains some tens of thousands of these intrinsically bright stars, and possibly a far greater number of dwarfs, which at present are beyond the reach of our telescopes. Of high importance is the fact that the cluster stars appear to be remarkably similar to the stars in the solar neighbourhood in spectral type, colour, variability, and other properties, notwithstanding the much higher stellar density near the centres of globular clusters.

Open clusters are of great variety. They range in brightness from naked-eye systems, such as the Hyades, to small, dim groupings that may be nothing more than chance aggregations of faint Milky Way stars. Open clusters vary also in richness, in apparent and real dimensions, in stellar content. One property they have in common: they are all near the plane of the Milky Way. The distance of the average open cluster is smaller than that of globular clusters, but the determination of distances for the former is generally subject to much uncertainty. This fact is due to variety of form and content, and to the absence from open clusters of peculiar types of highly luminous stars, which for globular clusters serve to determine positions in space.

The estimation of the distances of globular clusters, which has been the most important part of the work on the scale of the sidereal universe, must be based on the newer methods of measuring space. The various trigonometrical methods, when applied to globular clusters, so far give negative results, indicating only that the distances are very great. The various photo-

metric methods that had to be developed for this problem involve a considerable amount of photometric, spectroscopic, and statistical detail when put on a quantitative basis, and cannot be fully described in this article.

The qualitative application of the photometric methods, however, is simple. For example, we need only assume that the brightest stars in a globular cluster have the same actual luminosity as the brightest stars in the solar neighbourhood, and we can readily compute the distance necessary to give them the apparent brightness that is measured.

If we admit the similarity of globular clusters, it is obvious that either the apparent magnitude or the apparent diameter can give us the distances of them all when once we have determined the distances of those nearer the earth. In practice the distances of the nearest clusters have been determined from studies of their variable stars, of their blue stars (spectral type B), and of their red giant stars; and checked by spectroscopically-determined absolute magnitudes and by means of the relative diameters. All the methods agree in giving distances of the same order of magnitude. We thus find that the globular clusters range in distance from seven thousand parsecs to values nearly ten times as great. Their diameters are of the order of a hundred parsecs. Their brightest stars are a thousand times as bright as the sun.

The Structure of the Galaxy.

The result of most interest that comes out of this photometric investigation is the enormous dimensions of the super-system of globular clusters and of the Galaxy. Once the positions in space are determined, it becomes clear, as had already been suspected from an inspection of the apparent distribution of clusters in the sky, that globular clusters are a part of the Milky Way system. They are associated physically with the system of stars, nebulæ, and open clusters which is more or less symmetrically arranged with respect to the equatorial plane of the Galaxy. In measuring the distances of the remotest globular clusters, therefore, we are but measuring the depth of our own galactic system. That the Milky Way itself extends to distances as great as those indicated by the clusters is shown by the presence within it of highly luminous types of stars with apparent magnitude 15 and fainter.

It has been known for many years that globular clusters are not uniformly distributed in galactic longitude. They are most numerous along the edges of the southern Milky Way. That one-sided distribution is now recognised as an indication of the sun's very eccentric position in the galactic system. In this same southern part of the sky we find the densest galactic star-clouds and the greatest frequency of faint novæ and of other types of distant objects, which is but further evidence of the greater depth of the galactic system in the direction of Sagittarius. Also in that general direction are some obstructing dark nebulæ, which may be wholly responsible for a peculiar phenomenon in the distribution of distant globular clusters, that is, in their seeming absence from regions very close to the galactic plane. If the obstructing material were removed, we might see, near the galactic plane, clouds of faint Milky Way stars still more dazzling than those observed, and globular clusters still more distant than those now known, and hence find that the greatest diameter of the galactic system is even larger than the value now assigned—approximately 100,000 parsecs.

The observable dynamical relations within and without the Milky Way are suggestive of its origin. No open clusters have yet been found outside the Milky Way region, but hundreds are known within. North and south of the galactic plane the globular clusters are equal in number, and their distances from the plane are much smaller than the greatest diameter of the system. Their velocities, so far as now known, are high. Many are approaching the galactic plane with speeds that soon must bring them to it. Their present positions and motions make orbital motion around the Milky Way improbable. From the present evidence as to mass, velocity, and distribution, there can be little doubt but that the known globular clusters pass to and fro through the star fields of the galactic system, notwithstanding their observed avoidance, apparent or temporary, at the present time. Every passage must reduce the velocity and alter the form. The hypothesis that these globular clusters are being diverted by degrees into galactic regions, and gradually robbed of their stars, is upheld by observation and is not opposed by present dynamical theory. Although we see few intermediates between the globular and the more typical open clusters, many of the characteristics of the open groups strongly support the suggestion that they are the remnants of globular clusters or of other systems that have been assimilated by the incomparably more massive galactic assemblage. Nearly a dozen "moving" clusters, comprising thousands of members, are recognised among the stars within seven hundred light-years of the sun.

Two important theoretical researches by Jeans are of much significance in this view of galactic structure: (i.) the form resulting from the interpenetration of two clusters,[3] and (ii.) the necessity, in accounting for the present orbits of long-period binaries, of assuming their former existence in a much more compact stellar field than now exists in the solar neighbourhood.[4] The high stellar frequency near the centre of a globular cluster would certainly supply conditions favourable for modifying orbits, and it also might aid in explaining the origin of long-period binaries which is not otherwise accounted for satisfactorily.

The determination, with the aid of clusters, of dimensions for the galactic system much larger than had been clearly indicated by studies of the nearer galactic stars, led to a further examination of the stellar distribution in the solar neighbourhood. The hypothesis that the galactic system, as we now know it, has developed from the combination of minor groups, suggests that the brighter stars near the sun may to a large extent be members of a local system that is imbedded in and moving through the general star fields of the Milky Way. This condition actually appears to be the case, and hence the results on galactic dimensions, from clusters and from the nearer stars, do not contradict. Stars of spectral type B down to the sixth apparent magnitude seem to be almost exclusively members of a local cluster or cloud. Brighter stars of Class A are also affiliated with the same system.[5] Probably all

the other types are to some extent involved,[6] but for them the disentanglement of local system and galactic field is more difficult.

Quite analogous to the phenomenon of the Milky Way, the projection on the sky of the faint stars along the central plane of this local cloud gives rise to a sort of secondary Galaxy,[7] the brighter stars of which coincide roughly with the Herschel-Gould belt. The distribution of the B stars indicates that the dimensions of the local system are large compared with those of a globular cluster; the local system is also more oblate. I believe it can be better compared in dimensions, and possibly in form, with the Magellanic Clouds or with the distinctly delimited small star clouds of the Milky Way. The various phenomena of star streaming are undoubtedly connected with the motions of and within the local system. Probably a number of our brighter "moving" clusters should be considered sub-systems in the local cloud, rather than independent systems which for the time being are near at hand.

(*To be continued.*)

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Transport of Organic Substances in Plants.[1]

By Prof. H. H. DIXON, Sc.D., F.R.S.

AMONG physiologists the usually accepted view is that organic substances are distributed throughout the plant by means of the bast. The wood also acts as a channel of distribution for these substances to opening buds and developing leaves, especially in spring when root-pressure is active. The sap of bleeding contains appreciable quantities of these substances, and their distribution to the developing buds in spring by means of the wood was recognised by Hartig and Sachs.

This upward transport of carbohydrates in the tracheæ seems to be accompanied with smaller amounts of proteins. Thus Schroeder showed that the quantity of proteins in the bleeding sap rises and falls with the quantity of sugar.

This view that the rising current in the tracheæ carries organic substances in it and distributes them to the growing regions has lately been impugned. It was pointed out that in many cases, ringing close below the terminal bud prevents the development of that bud because the wood is unable to transmit sufficient supplies of organic substance. As Strasburger has already shown, this interpretation rests upon the fallacy of supposing that the removal of the bark as far as the cambium leaves the wood uninjured. As a matter of fact, microscopic examination of the wood, from which the outer tissues have been stripped, shows that its tracheæ soon become blocked with air-bubbles and with substances probably exuded into them and their walls during morbid changes in the cells of the cambium, in the cells of the medullary rays, and in those of the wood-parenchyma. The blocking is accompanied with discoloration, and is most apparent in the outer layers of the wood. It is only reasonable to suppose that the efficiency of the tracheæ as channels of transmission is seriously impaired even before there is visible evidence of plugging.

It is evident that this clogging may act differentially on the water and the substances carried in it. In the first place, the whole cross-section of the wood is available for the transport of water, while probably the outer layers are mainly utilised by the organic substances. Further, colloidal deposits in the walls, and especially in the pit-membranes, would obstruct the passage of organic substances much more than they would the water which carries them. These considerations readily explain how it is that, while the water-supply to the buds of ringed branches is adequate, the supply of organic substance may be deficient.

Apart, then, from the very slow movement of organic substances from cell to cell, there is very cogent evidence that their upward motion is effected in the tracheæ of the wood. There is no reason to believe that during this transport the walls or pit-membranes of these tracheæ oppose the passage of the dissolved carbohydrates or of the simpler proteins any more than the water which conveys them. Hence the velocity of transport of these organic substances is that of the transpiration current, and the amount conveyed in a given time depends on the velocity and concentration of the stream.

The transport of organic substances in an upward direction in plants is secondary, for, as is well known, carbohydrates certainly, and proteins most probably, are manufactured only in the upper green parts of plants—principally in the leaves, and must be transported in the first instance back from these to the stems to be distributed to the growing regions and to the storage organs.

This view that the channel for the backward and downward movement of organic substances is afforded by the bast received great support from Czapek's work published in 1897. By section of the conducting tracts in one half of the petiole he showed that depletion of the corresponding half of the blade was delayed. He also showed that only where vertical bridges connected the upper and lower portions of bark in ringed stems were the effects of ringing nullified. Oblique and zigzag bridges are ineffective. Thus transverse conveyance in the stem is negligible. The parallel and longitudinal arrangement of the elongated elements in the bast seemed to him to provide adequately for the observed longitudinal passage. Their narrowness and large colloid content did not present themselves as difficulties. Czapek also recorded the observation that the blades of leaves, the petioles of which had been killed by jacketing them with steam, did not become emptied of starch. Similarly, when the petioles were killed with chloroform-vapour, depletion was arrested. Again, anæsthetisation of the petiole, by surrounding

[1] From the presidential address delivered to Section K (Botany) of the British Association at Hull on Sept. 7.

it with a watery solution of chloroform, greatly delayed the disappearance of starch.

Czapek formed no definite theory as to how organic substances were moved in the bast. He was sure that the transport depends on living protoplasm. He did not consider that the streaming of protoplasm contributed materially to the motion, seeing that streaming does not occur in mature sieve-tubes. He regarded the sieve-tubes as the most important elements in the transmission of these substances, because the deposition of callus in the sieve-plates synchronises with the stoppage of transport. The transport, according to him, is not simply due to diffusion. He supposed the protoplasm to take up the organic substances and pass them on. If diffusion does not account for the passage from one particle of protoplasm to the next, it would seem that we must suppose the organic substance to be projected from one to the other.

These observations and their interpretation by Czapek have strengthened the opinion that the bast is the channel for the downward transport of organic substances. It is remarkable how little weight has been attached to the damaging criticism of Czapek's views by Deleano, especially as those views are so unsatisfactory from a physical point of view.

The latter author showed that it is inadmissible to compare externally similar leaves, which often behave, so far as depletion is concerned, very dissimilarly. He also pointed out that without any export a leaf may be depleted of all its starch within thirty-five hours, and partially anticipated an extremely interesting recent observation of Molisch—namely, that transpiring leaves lose their carbohydrates much more rapidly than those the transpiration from which is checked by being surrounded with a saturated atmosphere. Neglect of these facts led Czapek into error. Deleano also showed that organic substances continue to leave the blades even after the petioles have been killed by heat or by chloroform-vapour. The rate of depletion is reduced by the former agent to about one-third, and by the latter to one-half. If this observation is substantiated it would show that the intervention of living elements is not essential for the transport. He further found that the blades attached to petioles which were surrounded by chloroform-water lost their starch more quickly than those immersed in water.

The contradictory conclusions of Czapek and Deleano urgently call for a reinvestigation of the points at issue. If Czapek's work holds good, we shall have to regard the bast, and especially the sieve-tubes, as the channels for the transport of organic substances back from the leaf-blades where they are manufactured, and we must look for some hitherto undreamed-of method of transmission through these most unlikely-looking conduits. On the other hand, if Deleano's conclusions are borne out, we should admit that protoplasm is not necessary for the transport, and we would turn to a dead tissue as furnishing this channel.

So far as I am aware none of the earlier investigators made any estimate either of the actual quantities of organic material which are transported or of the velocities of flow in the channels which are necessary to effect this transport.

We may approach this problem from two opposite directions—(1) by dealing with the amount of organic substance accumulated in a given time in a storage organ, or (2) by using the amount exported from an assimilating organ. The cross-section of the supposed channels of transport and the volume of the solution containing the substances in each case will give us the other necessary data.

For the first method a potato-tuber will furnish an example. One weighing 210 g. was found attached to the base of a plant by a slender branch about 0·16 cm. in diameter. In this branch the bast had a total cross-section of 0·0042 cm.^{2}. This figure is a maximum; no allowance was made for the cross-section of the cell-walls, or for any non-functional elements in the bast. The cell-walls would occupy probably one-fifth of the cross-section of the bast. Now if the bast exclusively furnished the channel of downward transport, all the organic substance in the potato must have passed this cross-section during the time occupied in the growth of the potato. One hundred days would be a liberal allowance. According to analyses more than 24 per cent. by weight of the potato is combustible. Therefore we must assume that during this time more than 50 g. of carbohydrate has passed down a conduit having a cross-section of no more than 0·0042 cm.^{2}. The average concentration of the solution carrying this substance could scarcely have been as much as 10 per cent. (2·5-5 per cent. would be more probable; the concentration of sugar in bleeding sap is much below this figure, and seems never to reach 4 per cent.). Assuming, however, this concentration, the volume of liquid conveying 50 g. must have been 500 cm.^{3}, and this quantity must have passed in 100 days. Therefore the average velocity of flow through this conduit, having a cross-section of 0·0042 cm.^{2}, must have been $\frac{500}{0{\cdot}0042 \times 100 \times 24}$, *i.e.* nearly 50 cm. per hour.

By the second method we arrive at a different figure. Various investigators, from Sachs onwards, have measured the rate of photo-synthesis per square metre of leaf per hour. Under the most favourable conditions the amount may approach 2 g., and it has been estimated as low as 0·5 g. Taking Brown and Morris's determination for *Tropæolum majus*, namely, 1 g. per square metre per hour, and assuming one-third of the carbohydrate formed is used in respiration in the leaf, we find that a leaf of 46 cm.^{2} may form during ten hours' sunshine 0·46 g.; during the twenty-four hours one-third of this will be respired, leaving 0·31 g. to be transported from the leaf. The volume of the solution (again assuming a concentration of 10 per cent.) will be 3.10 cm.^{3}. The cross-section of the bast of the bundles in the petiole was 0·0009 cm.^{2}; therefore the velocity of flow, if the bast was used as the channel of transport, must have been $\frac{3{\cdot}10}{0{\cdot}0009 \times 24}$ or 140 cm. per hour.

Similar figures to these were derived using measurements obtained from a number of potato-tubers and from various leaves. The velocities indicated, even assuming a concentration of 10 per cent., lay in all cases between 20 cm. and 140 cm. per hour. These figures are in agreement with those arrived at by Luise Birch-Hirschfeld, as to the weight of organic material transported from leaves.

A flow of this rate through the bast seems quite

impossible. The narrow transverse section of its elements, the frequent occurrence of transverse walls, and the lining of protoplasm and large protein contents practically preclude the mass movement of liquid through this tissue. If we imagine the flow restricted to the sieve-tubes the velocity must be correspondingly increased, and the excessively fine sieve-pores, more or less completely occupied by colloidal proteins, must be reckoned with. Simple diffusion, as Czapek recognised, cannot account for the transport, and there is no reason to suppose that adsorption on the surfaces of the colloid contents of the sieve-tubes can increase the velocity of diffusion, as Manghan suggests.

As soon as one realises the volume of the solution which has to be transported, and the velocity of the flow that this necessitates, one naturally turns to consider if the open capillary tubes of the wood may not be utilised as channels of transport. Deleano's results, indicating that the depletion of leaves continues even after the living elements of their petioles have been killed, support this conjecture.

The emphasis which has been laid on the function of the wood as providing a channel for the upward movement of water usually obscures its function as a downward and backward channel also. Early experimenters, however, fully recognised that, under certain conditions, the current in the wood may be reversed. There is, of course, recent work also showing this reversed current.

By means of an eosin solution this reversal of the transpiration current may be very easily demonstrated. If the tip of a leaf of a growing potato-plant is cut under eosin solution, the coloured solution is very quickly drawn back into the tracheæ of the conducting tracts of the leaf; from there it passes into those of the petiole, and makes its way not only into the upper branches and leaves, but also passing down the supporting stem may completely inject the tracheæ of the tuber, and from thence pass up into the wood of the remaining haulms of the plant. Its passage is entirely in the tracheæ of the wood of the conducting tracts.

Another very striking experiment may be carried out with the imparipinnate leaf of *Sambucus nigra*. Its petiole is split longitudinally for a few centimetres and half removed. The remaining half is set in a solution of eosin. The solution is rapidly drawn up the wood-capillaries of the intact half-petiole, and soon appears in the veins of the pinnæ on the same side of the leaf, beginning with the lowest, and gradually working up into the upper ones. Finally it appears in the terminal pinna. All this while the veins of the pinnæ on the other side remain uncoloured. Now, however, the eosin begins to debouch into the base of the uppermost of these pinnæ and spreads through its veins; finally it makes its way down the offside of the rachis to the bases of the lower pinnæ, and from thence spreads into their veins. In this case we see very clearly how transpiration actuates an upward current on one side and a downward current on the other. It is interesting to note that if the terminal pinna and its stalk is removed the eosin does not appear in the pinnæ of the second side, or only after a considerable time, when the small anastomosing conducting tracts are utilised.

Luise Birch-Hirschfeld also described recently many experiments with herbaceous and woody plants, tracing the path of the reversed current by means of lithium nitrate and eosin.

In all these cases the tension of the sap determines the flow from a source wherever situated, and transpiration from the leaves, or parts of leaves, which are not supplied with liquid water from without, draws the water through the plant along the channels of least resistance. Hence it is that if the cut vein of a lateral pinna provides the point of entry, the solution may pass backwards in some of the conducting tracheæ, leaving others quite uncoloured, so that some of the veins only of the pinna are injected. The injected tracts bring the solution down the rachis and petiole into the stem, while a few or many, as the case may be, remain filled with colourless liquid, presumably the sap drawn upward to supply the transpiring surfaces of the leaf. Generally the coloured liquid descends an appreciable distance in the tracheæ of the stem before it begins to rise in the ascending current, mounting to other transpiring leaves. As a rule after some time—depending on the rate of transpiration and the amount of water supplied by the roots—the presence of the coloured liquid may be demonstrated in certain continuous series, or filaments of tracheæ in several bundles of the lower parts of the stems. Similarly, if tubers or rhizomes are present, examination of these parts, after a suitable interval, will show that many of their filaments of tracheæ are injected. Meanwhile the parts above the supplying leaf become coloured, and it will be seen that the distribution of coloured tracheæ is decided by the anatomical connexions of those filaments of tracheæ which convey the coloured liquid directly from the point of supply through the petiole to the stem. In tracing the path of the solution one is impressed with the fact that the path of least resistance is by no means always the shortest path in the wood. Transverse motion across several tracheæ seldom occurs, and the separate linear series of conducting tracheæ are practically isolated from each other laterally. Here we may recall Strasburger's experiments showing the very great resistance offered to the flow of water in a transverse direction in the wood of trees. This isolation of the separate filaments of tracheæ in the leaf and in the stem enables the tension developed by the transpiring cells of the leaves, while it raises a column of water in one series of tracheæ, to draw down a solution in a neighbouring filament of tracheæ terminating above in some local supply. If the anatomical connexion of the two series is located in a subterranean organ the tracheæ of the subterranean organ may become filled from that supply.

So far the evidence of reversed flow in the water-conducting tracts which we have been considering has been derived from plants under artificial conditions—plants the conducting tracts of which have been cut into and otherwise interfered with. Is there any evidence that reversal of the transpiration-current normally occurs in uninjured plants?

Some recent work on the transmission of stimuli seems to me to indicate that these reversals are continually occurring in normally growing plants.

The first piece of work to which I would direct attention is that of Ricca on Mimosa. It has long been known that the stimulus which causes the folding of the

pinnules and the bending of the petioles of Mimosa could traverse portions of the petioles or stems which had been raised to such a temperature as would kill the living elements in these organs. Notwithstanding that observation, Haberlandt's view, that the stimulus is transmitted as a wave of pressure through certain tubular elements of the bast, was generally accepted as the least objectionable of any of the theories which had been put forward to explain this transmission. Ricca saw that, among other difficulties, the slowness of transmission—never more than 15 mm. per second—was a grave objection to this view. Accordingly, working with a woody species of Mimosa—*Mimosa Spegazzinii*—he removed the whole bast and outer tissues of the stem for as many as twenty-three centimetres and was able to show that the stimulus was still transmitted. Similarly he found that the stimulus was transmitted through narrow strips of the wood from which even the pith had been removed. These experiments and others in which the transmitting organ had been killed for a considerable length caused Ricca to recognise that the stimulus is transmitted in the wood and not in the bast, as had been previously held. Thus he was led to assign the transmission to the transpiration-current. He was able to confirm this conjecture by showing that the transmission to the various leaves of a plant is largely controlled by the rate of the transpiration from the individual leaves. Thus, other things being equal, a rapidly transpiring leaf receives the stimulus sooner than a sluggishly transpiring one equidistant from the point of stimulation. He was able to show further that the stimulus may be transmitted through a glass tube filled with water, just as it is transmitted through a dead portion of the stem. Evidently a hormone set free into the transpiration-stream is the long-sought-for mechanism by which the stimulus is transmitted throughout Mimosa.

As the stimulus travels both in a basipetal and acropetal direction we may assume that movement of the transpiration-stream in a downward direction is of normal occurrence in plants.

Contemporaneous with, and subsequent to, Ricca's important work on Mimosa, experimental evidence has been accumulating to indicate that the transmission of other stimuli — phototropic, traumatotropic, thigmotropic, and geotropic — is effected by means of the passage of a dissolved substance. Boysen-Jensen appears to have been the first to announce that phototropic and geotropic stimuli may be transmitted across protoplasmic discontinuities. Paál emphasised this by showing that these stimuli are able to pass a disc of the tissue of *Arundo donax* impregnated with gelatine, which is interposed between the receptive and responding regions. These observations rendered the view that the stimulus is transmitted in the form of a hormone extremely probable; and later Stark showed that this hormone is thermostable, just as Ricca had done in the case of the hormone of Mimosa. Another very interesting point discovered by Stark—working with traumatic stimuli—is that the hormones are to a certain extent specific. Thus if the perceptive tip of a seedling is removed from one plant and affixed in position on another, the certainty of the response depends on the genetic affinity of the two plants.

In all these cases it seems certain that the perceptive tissues are the point of origin, when stimulated, of a dissolved substance, the hormone, which makes its way to the motile tissues and releases the response.

In the case of Mimosa just alluded to, and of the labellum of Masdevallia examined by Oliver, there is direct evidence that the transmission of the hormone is effected by the vascular bundles. In Mimosa the channels are more precisely localised as being the tracheæ of the wood. Furthermore, the rapidity of transmission renders it certain that simple diffusion through the tissues of the plant will not account for the process. Some recorded velocities of transmission are here enumerated for the sake of comparison:

Plant.	Nature of Stimulus.	Transmission Time in secs. per mm.
Mimosa	Heat	0·07
Drosera	Chemical	6·00
Seedling	Light	180-300
,,	Gravity	300
Tendril	Contact	17
Diffusion in tissue		2250-3600

There is thus every reason to believe that the transmission of stimuli generally through the tissues of the higher plants is effected by the conveyance of a hormone in the wood of the vascular bundles from the receptive to the motile regions, and whenever this transmission is in a downward direction evidence is afforded of the downward movement of water in the tracheæ. It is reasonable to suppose that this downward current is able to carry organic foodstuffs as well as hormones.

Thus the evidence for the existence of a backward flow of water in the tracheæ of wood, in addition to the more obvious upward stream, is convincing. With regard, however, to the mechanism by which the backward stream is supplied we have but scant information.

The volume-changes of leaves which Thoday has recorded are suggestive in this connexion. These changes he found of various magnitudes, occurring simultaneously in different or in the same leaves. They may cause a linear contraction amounting to 2·5 per cent. in ten minutes, and may produce a volume contraction of 7 per cent. in the same time. The water corresponding to this volume-change in the cells of the leaf if transmitted into the tracheæ would produce a considerable downward displacement, as may be seen from the following figures:

Name of Plant.	Volume of 1 per cent. Contraction in mm^3.	Cross-section of Tracheæ in Petiole in mm^2.	Downward Movement in cm.
Aucuba japonica .	22·8	0·05	45·6
Solanum tuberosum	28·0	0·07	40·0
Syringa vulgaris .	42·15	0·013	16·5
Acer macrophyllum	42·2	0·22	19·2

If these changes in volume are caused by, or accompanied with, a development of permeability of the contracting cells, evidently a backward movement of organic substance having a velocity of about 120 cm. and more per hour would be produced.

It is possible that the tension which causes these contractions of the leaf-cells at the same time acts as a stimulus to increase the permeability of the plasmatic membranes of the cells; and so one might imagine that the development of a certain tension would automatically release organic substances from the cells and draw them through the tracheæ downwards. Direct experiment on this point presents difficulties, but it may be worth recording that when the internal osmotic pressure of the leaf-cells was overbalanced by an external gas-pressure, the water pressed from the cells and forced out of the tracheæ of the supporting stem was found to be practically pure, and if it contained carbohydrates they were in such small quantities that no reduction could be detected with Benedict's solution either before or after inversion. This experiment was repeated several times with branches of *Sambucus nigra* and *Tilia americana*. The cut branch, well supplied with water, was first exposed for several hours to conditions favourable to photosynthesis, and then either immediately or after a sojourn in darkness subjected to the gas-pressure. A pressure of thirteen atmospheres was found sufficient to drive water back from the leaves out of the stem.

Of course the conditions of this experiment are not those obtaining in the normal plant, where during transpiration the volume of a leaf, or part of a leaf, changes. In the transpiring plant we can also imagine the accumulation of a substance or an ion which would give rise to an alteration of the permeability of the plasmatic membranes of the leaves.

When, in order to imitate these conditions, the cells of the leaves in the foregoing experiment are rendered permeable by the introduction of a little toluene into the pressure-chamber, the application of a smaller pressure is sufficient to press the cell-contents into the water-channels and liquid emerges from the base of the stem which readily reduces Benedict's solution.

In the same way, if a pinna of *Sambucus nigra* is surrounded with toluene vapour, transpiration from the adjacent pinnæ draws back the cell-contents of the toluened pinna, and afterwards their track in the wood of the vascular bundles of the rachis may be traced by the browning of this tissue.

Another possibility presented itself, namely, that the direction of the current might act as a stimulus regulating the permeability of the cells in contact with the tracheæ. To test this, short lengths of stem set in their normal position were supplied, first through their lower and afterwards through their upper end, with distilled water. In neither case could carbohydrates be detected in the issuing stream.

The foregoing short consideration of some recent physiological work leads us, then, to the following conclusions:

The transport of the organic substances needed in the distal growing regions is effected through the tracheæ of the wood. The substances travel dissolved in the water filling these channels, which is moved by transpiration, expansion of the growing cells, or root pressure.

Physical considerations forbid us admitting that sufficiently rapid transport can be afforded by the bast either for the observed upward or downward distribution of organic substance.

The existence of downward as well as upward movement of water in the tracheæ of the wood may be demonstrated by suitable experimental means, and may be inferred by the transport of hormones in the wood.

The occurrence of local contractions in leaves suggests that local increases of permeability supply dissolved organic substances to the distal ends of certain of the filaments of tracheæ. The tension developed by the transpiration of other regions draws these along downward as well as upward channels in the wood.

In thus ruling out the participation of the bast in the longitudinal transport of organic substances in plants one naturally is forced to speculate on its probable function. Its distribution and conformation are such that, while it possesses a very small cross-section, it appears with the other living elements of the vascular bundles, medullary rays, wood-parenchyma, etc., to present a maximum surface to the tracheæ.

This large surface may find explanation in the necessity of interchange between the living cells and dead conduits. The colloidal contents of the former render this process slow, hence the necessity for the large surface of interchange to enable sufficient quantities of organic substances to be abstracted from and introduced into the tracheæ to meet the needs of the plant.

Before concluding I would like to add that the experimental work carried out on this matter would have been quite impossible for me were it not for the assistance and ingenuity of Mr. N. G. Ball. He also has contributed materially by his criticisms and suggestions.

Obituary.

COLONEL E. H. GROVE-HILLS, C.B.E., C.M.G., F.R.S.

COLONEL EDMOND HERBERT GROVE-HILLS, whose death occurred on October 2 at his residence at Campden Hill, W., was the son of Herbert A. Hills of High Head Castle, Cumberland. Born on August 1, 1864, he was educated at Winchester, whence in 1882 he passed into the Royal Military Academy, Woolwich. There his abilities were recognised as giving promise of a distinguished career, and he passed out as the senior cadet of his term, receiving a commission in the Royal Engineers in 1884.

Scientific subjects specially interested him, and in 1893 he was elected a fellow of the Royal Astronomical Society; in the following year a paper by him on the photographs of the spectrum of the eclipsed sun taken at the solar eclipse of April 1893 was communicated to the Royal Society. The study of solar physics strongly attracted him, and he also took part in the eclipse expeditions of 1896 to Japan, of 1898 to India, and in that of 1914 to Kieff, whence he was recalled on the outbreak of war to military service. In 1898 he took up the appointment of instructor in chemistry and photography at the School of Military

Engineering, but he had only held this for a year when he was transferred to the Topographical Section of the General Staff at the War Office. Here his scientific inclinations found full scope in the organisation of survey work in all parts of the world. During his tenure of the post he raised the standard of this work in a very notable degree, which was recognised by the C.M.G. being conferred on him in 1902. His work here brought him into contact with many problems in geodesy, in which he took a keen and lasting interest. At this time Sir David Gill was actively promoting the geodetic triangulation in South Africa, and to this Grove-Hills gave his whole-hearted support.

In 1905 he completed his period of service as head of the topographical department of the War Office, and then retired from the army. In the following year he contested Portsmouth in the Conservative interest unsuccessfully, and afterwards occupied himself mainly with scientific investigations. At the British Association in 1906 he raised the question whether the triangulation of this country was of the accuracy required by modern geodesy, and a few years later the Ordnance Survey undertook the re-observation of certain triangles in Scotland to determine this point. In the same year he and Sir Joseph Larmor discussed the movement of the pole in an important communication to the Royal Astronomical Society.

Col. Grove-Hills was president of Section E at the British Association meeting in 1908, where he discussed the surveys of the British Empire in an important address. He had before this been invited to report on the Canadian surveys and wrote a valuable and instructive report on them. In 1911 he was elected a Fellow of the Royal Society, and from 1913 to 1915 he was president of the Royal Astronomical Society. He was also latterly Secretary of the Royal Institution. Keenly interested in astronomy, he designed the suspended zenith instrument at Durham Observatory, of which institution he was Honorary Director up to the time of his death. While on his way to Kieff with the eclipse expedition of 1914 he was recalled to take his part in the Great War, and was appointed Assistant Chief Engineer of the Eastern Command, being gazetted Brigadier-General in 1918. His services in this responsible post were recognised by the award of the C.B.E. in 1919.

Endowed with very great natural ability, and a keen interest in all scientific questions, Grove-Hills combined with these great administrative ability and sound common sense. He was always ready to assist by his advice and active co-operation in any well-planned scheme of scientific work, and in his death astronomy and geodesy have suffered a severe loss.

H. G. L.

MAJOR-GENERAL J. WATERHOUSE.

MAJOR-GENERAL JAMES WATERHOUSE, who was eighty years of age, died on September 28. As a youth he joined the Royal Bengal Artillery, and after seven years was made Assistant Surveyor-General in charge of the photography section in the Surveyor-General's Office in Calcutta. He retired in 1897. His official duties necessitated the study of photography and photo-mechanical methods of reproduction, and this he did with a keen eye for any possible improvement, and a skilful hand which enabled him to test the practical value of any new introduction. He made an extended continental tour during his term of office that he might become acquainted with the methods employed in foreign photographic laboratories. A considerable number of improvements were introduced by Waterhouse in photolithography and allied processes, as well as in collotype, sometimes varying methods in use elsewhere to render them suitable for a tropical climate. His knowledge of these methods in all their minutiæ was very extensive, and in 1882–1885 he contributed to the *Photographic News* a series of fifty chapters on photolithography.

In 1873, when Vogel published his discovery that the sensitiveness of plates to green and red could be enhanced from a negligible to a practically useful amount by the use of certain dyes, Waterhouse was one of the very first to confirm the observation and to find other effective dyes. In 1890 he found that by the addition of thiourea to the developer the reversal of the image was so much facilitated that a very little, if any, increase of exposure was necessary. He took part in the observation of the total eclipses of 1871 and 1875, and in the transit of Venus in 1874.

On his retirement, Waterhouse studied the early history of the camera obscura, and of the action of light on silver salts, correcting some false and incomplete ideas that were current. He was president of the Royal Photographic Society from 1905 to 1907, honorary secretary of the Calcutta Zoological Gardens from 1894 to 1897, president of the Asiatic Society of Bengal from 1888 to 1890, and trustee and twice chairman of the Indian Museum at Calcutta. The value of his scientific work in connexion with photography was acknowledged by the award to him of the Progress Medal of the Royal Photographic Society, and the Voigtländer Medal of the Vienna Photographic Society.

WE regret to record the death of Prof. J. K. A. Wertheim Salomonson. He was born in 1864, passed his medical studies at the University of Leyden, and in 1899 became professor in neurology and radiology in the University of Amsterdam. His contributions to these two subjects were of considerable importance, for his range of knowledge of medicine and physics was supplemented by a perfection of skill in instrumental design. He was a frequent visitor to this country and only last year he demonstrated to the Ophthalmological Section of the Royal Society of Medicine a method for the photography of the structure of the eye. He was responsible for improvements in the electro-cardiograph and in many instruments designed for radiological purposes. A man of engaging personality, his loss will be felt over the wide circle which his scientific interests served. He was a Knight of the Order of the Lion of the Netherlands and an honorary member of the Röntgen Society. At the time of his death he held the office of rector magnificus at the University of Amsterdam.

Current Topics and Events.

AN announcement was made in the Press on October 10 by the British Broadcasting Company concerning the conditions which, in order to obtain Post Office approval, must be fulfilled by receiving apparatus intended for use in connexion with the broadcasting services. The conditions have been framed with the view of preventing the use, in such sets, of circuits which may "regenerate" oscillations and thus cause disturbances at receiving stations within their re-radiation range. Experience has indicated the need, in the case of receiving apparatus handled by an unskilful user, for some form of control in the type and design of the apparatus of the nature which is aimed at in the specification in question; the specification accordingly should serve a useful purpose. Exception has been taken in some quarters to the provisions contained in clause 10 of the conditions above referred to, on the ground that these particular conditions conflict with the promise made by the Postmaster-General in the House of Commons on July 27 last, to the effect that the owners of "home-made" receiving apparatus and the existing licencees of imported receiving sets would be allowed to use their apparatus for listening-in to broadcasted news, music, etc. This clause provides, *inter alia*, that "All sets sold under the broadcast licence shall bear the registered trade mark of the broadcasting company and the Post Office registered number." It has consequently been assumed that the issue of licences for receiving broadcasted matter will be confined to those who procure listening sets from the broadcasting company. It appears to have been overlooked, however, that the announcement to which attention is directed above has been issued by the British Broadcasting Company and relates alone to the conditions to be fulfilled by the receiving sets which are to be offered for sale to the public by members of that corporation. No declaration has so far been made by the Post Office which in any way indicates that the Postmaster-General contemplates the adoption of a policy at variance with that which he informed Parliament it was his intention to pursue in this matter; nevertheless, it is distinctly unfortunate that, in all the circumstances of the case, an official statement has not been issued by the Post Office setting out fully and frankly what course it is intended to pursue in relation to the grant of licences generally.

THE assignment to science of the proceeds of the first performance of a great play by a leading dramatist is an act which we record with much satisfaction. The play was the remarkable tragedy "Judith," by M. Henri Bernstein, produced at the Gymnase Théâtre, Paris, on October 12, before a brilliant and distinguished assembly, which comprised ministers of State and the chief social and intellectual leaders of the city. The Paris correspondent of the *Daily Mail* states that the receipts were for the benefit of the French Confederation of Scientific Societies, and the *Times* correspondent announces that more than 1000*l.* was raised by the performance. M. Bernstein gave his royalty as author, and Mme. Simone, who took the title part and obtained the greatest triumph of her career, devoted her fee to the same beneficent purpose. We cannot recall any like association of drama with science in Great Britain, and it is difficult to conceive of the proceeds from a first night being devoted to a scientific institution in this country. If, however, Sir James Barrie, Mr. Bernard Shaw, Mr. Oscar Asche, or any other of our leading dramatists or theatre managers should be inclined to follow the example which Paris has given us, we commend to their attention as eminently worthy of support such confederations as the British Association, British Science Guild, and the Conjoint Board of Scientific Societies.

THE August number of the *Journal of Indian Industries and Labour* contains two articles on State control in the field of industrial enterprise. Mr. C. Y. Chintamani, Minister of Education and Industries in the United Provinces, deals with the subject in an article entitled "The Limits of State Aid to Industry," with special reference to the work of the department of which he is in charge, while Mr. A. Y. G. Campbell contributes the first part of an article on the functions of provincial departments of industries in which the whole question of State assistance is reviewed. Mr. Campbell speaks from experience, as he himself held for some years the post of Director of Industries in Madras. Another feature is an extract from the presidential address delivered to the Mining and Geological Institute of India in January 1922 by Dr. Leigh Fermor, officiating director of the Geological Survey of India, in which is described the practical utility of a State geological department. Dr. Fermor declares that in royalties alone the receipts accruing annually to the Provincial Governments and other owners of mineral rights in India in respect of the eight most important minerals, excluding salt and saltpetre, amount to at least 560,000*l.* The *Journal* also contains the usual summarised accounts of the activities of the Provincial Departments of Industries during the preceding quarter.

THE council of the Institution of Mining and Metallurgy has awarded the Gold Medal of the Institution to Sir Alfred Keogh, "on the occasion of his retirement from the Rectorship of the Imperial College of Science and Technology, in recognition of his great services in the advancement of technological education and as a mark of admiration and respect." The council of the Institution of Mining Engineers has awarded the Medal of the Institution to Sir George Beilby, "in recognition of his valuable contributions to science, with special reference to his researches on fuel." The medals will be presented at the combined dinner of the two institutions to be held at Guildhall, London, on November 16, at which the Prince of Wales and several ministers of State will be present.

DR. M. O. FORSTER was entertained at dinner by a number of his chemical friends on October 6 on the eve of his departure to India to take up the duties of his new appointment as director of the Indian Institute of Science at Bangalore. He left England on October 13 by the P. and O. steamship *Morea*.

IT is stated in the *Chemiker Zeitung* of September 14 that Prof. Wieland has been appointed to the editorial board of *Liebig's Annalen* in place of the late Prof. Wislicenus. The board consists, in addition, of Profs. Wallach, Graebe, Zincke, and Willstätter. In the issue of September 26 it is announced that Dr. Noddack has been appointed director of the Physikalisch-Technische Reichsanstalt.

AT the inaugural meeting of the eighty-first session of the Pharmaceutical Society's School of Pharmacy, Bloomsbury Square, on October 4, the Hanbury medal, awarded every two years for the promotion of research in the chemistry and natural history of drugs, was presented to Prof. Emile Perrot, professor of materia medica in the University of Paris.

THE fifth annual Streatfeild Memorial Lecture will be delivered by Prof. C. H. Desch in the Chemical Lecture Theatre of the Finsbury Technical College, Leonard Street, E.C.2, on Thursday, November 2, at 4 o'clock. The subject will be "The Metallurgical Chemist."

THE forty-fifth anniversary of the Institute of Chemistry will be celebrated by a dinner to be held at the Hotel Victoria, Northumberland Avenue, W.C.2, on Friday, November 17.

ON Tuesday, October 10, members of the Circle of Scientific, Technical, and Trade Journalists accepted the invitation of Holophane Ltd. to visit the new showrooms and laboratories, where an address was delivered by Captain Stroud, and a demonstration of the latest scientific devices for distributing artificial light was arranged. In addition to standard types of reflectors for use in streets, factories, shops, etc., several interesting novelties were shown, including the new unit equipped with Chance's daylight glass to produce "artificial daylight." The appearance of coloured surfaces under this light, as compared with that of ordinary electric lamps, was demonstrated in the laboratory, where apparatus for obtaining polar curves of light distribution was also shown in operation. Mr. Leon Gaster, in returning thanks on behalf of the visitors, remarked that the scientific application of light was a subject of general interest to the technical press. Its importance was illustrated by the appointment, in 1913, of a Home Office Committee on Lighting in Factories and Workshops. It was hoped that in future each scientific advance would be brought to the notice of the technical press, which acted as an educational link between the expert and the general public.

THE seventy-sixth annual meeting of the Birmingham and Edgbaston Debating Society was held on October 4. The visitors included Alderman David Davis (Lord Mayor of Birmingham), Dr. R. Wakefield (Bishop of Birmingham), Dr. McIntyre (Archbishop of Birmingham), Mr. C. Grant Robertson (principal of Birmingham University), Mr. C. A. Vince (president of Birmingham Central Literary Association), and Mr. Arthur Brampton (president of Birmingham Liberal Association). Mr. G. Austin Baker was elected president for the ensuing session. Mr. Harry Jackson, the retiring president, delivered an address on "The Trend of Human Development." He showed that whereas in the past the environment and progress of man was limited to tangible things, to-day it extends more and more to regions outside the immediate perceptions of the senses. The views of Einstein, as contrasted with those of Newton, are a typical example and represent a great and intrinsic mental advance. The individual with the super-sensitive faculty in some particular direction must be given the scope and opportunity for the full expression of his genius. Humanity cannot afford to let clever men wear out their genius in providing themselves with the necessities of life. The most advantageous application of national wealth will be the maintenance of those who are able to work in the higher environment of the intellect.

MR. A. RADCLIFFE BROWN has sent us a long letter complaining of the review of his book—"The Andaman Islanders"—in NATURE of July 22, p. 106. The gist of the reviewer's criticism was that Mr. Brown spoilt a good plan—namely, of stating his own observations and where they differed from those of his chief predecessor, Mr. E. H. Man—by so carrying it out as to lead the reader to suppose that Mr. Man's work was not worth much. Mr. Brown's defence is that in adopting his plan of procedure he was obeying the instructions of the Anthony Wilkins Studentship, under whose auspices his work was undertaken. The reviewer did not complain of the plan but of the method of carrying it out. Next, with regard to the reviewer's criticism of the unwisdom of adopting the *Anthropos* Alphabet of Pater Schmidt for his work in supersession of the long-established alphabet compiled by so competent an authority as Mr. A. J. Ellis, Mr. Brown writes that he has "no hesitation in accepting the *Anthropos* Alphabet as the nearest approach possible at the present time to a scientific universal alphabet." But at the same time he quotes the fact that Sir Richard Temple published a universal grammar which has not been adopted to any extent by other writers, "doubtless because of the objection they feel to giving up the system of grammar to which they are accustomed." Mr. Brown, having thus the fate of Sir Richard Temple's grammar before him and appreciating the reason for it, might have been warned of the fate awaiting the *Anthropos* Alphabet, and that the only result in the circumstances of partially adopting it in a work, which he himself says "does not deal with the languages of the Andamans," would be to puzzle, and not enlighten, the student. To the reviewer's criticism of use being made without acknowledgment of information gathered by living predecessors, Mr. Brown raises the defence that any passages bearing such an interpre-

tation must have occurred in the introduction " which was meant as such and nothing more." It certainly does not justify the " correction " of the work of highly experienced local officials with not only the people and the country before them, but also the possession of the official technical works and some of the other general books, on which Mr. Brown relies for his facts.

IN a book entitled " Science and Human Affairs," which Messrs. George Bell and Sons, Ltd., will shortly publish, the author, Dr. W. C. Curtis, will recount how the conveniences of daily life and the safeguards to health have been discovered, and the possible bearing of science on human affairs in the future.

THE following catalogues, which should be useful to readers of NATURE, have just reached us: No. 95 (of Botanical and Zoological Works) from Messrs. Dulau and Co., Ltd., 34 Margaret Street, W.1; No. 216 (of Periodicals, Collections, Transactions, and Publications of Learned Societies, etc.) from Messrs. W. Heffer and Sons, Ltd., Cambridge; and No. 372 (miscellaneous, including Natural and Physical Sciences) from Messrs. Bernard Quaritch, Ltd., 11 Grafton Street, W.1.

MESSRS. LONGMANS AND CO. have in preparation, in four volumes, " A Natural History of the Ducks," by Dr. J. C. Phillips, of the Museum of Comparative Zoology, Cambridge, Mass., U.S.A., which will aim at giving an exact and detailed description of all known species of ducks, mapping their breeding and migration ranges. It will also contain full life-histories of the European and American species. The work will be illustrated in colour and in black and white by F. W. Benson, A. Brooks, and L. A. Fuertes. Vol. 1 is nearly ready for publication.

SIR RONALD ROSS is bringing out, through Mr. John Murray, a work entitled " The Great Malaria Problem and its Solution: an Autobiographical Account," which will give a complete history of the discovery of the relation between malaria and mosquitoes, showing how malaria is carried from man to man. Another book in the same publisher's announcement list is " Gardening for the XXth Century," by C. Eley, in which attention is chiefly directed to the more permanent features in gardens. The work will contain a list of selected trees and shrubs, with descriptive and cultural notes, and brief chapters upon botany and nomenclature.

Our Astronomical Column.

MERCURY VISIBLE AS A MORNING STAR.—Mercury will reach its greatest elongation, 18° 38′ west, in the early morning of October 31, and will be visible before sunrise during the period from about October 22 to November 10. The planet will rise about $1\frac{3}{4}$ hours before the sun, and should be easily visible about an hour before the times of sunrise. Its position will be near the horizon in E. by S., and it will shine with a rosy, fluctuating light about equal to that of a first magnitude star.

The planet Saturn will be very near Mercury on about October 23, when the distance separating the two orbs will be a little more than 2°.

Telescopic observations of Mercury are much required, the exact time of the planet's rotation being doubtful. It is a good plan for those observers who do not possess equatorial telescopes to pick up the planet when it is visible to the naked eye, and to get and retain the disc in the field of view of the instrument until some time after sunrise, when it will have risen sufficiently high above the vapours near the horizon to permit the image to be well defined. Mercury certainly presents dusky markings which are capable of being followed when clear weather allows, and the planet offers a much better prospect for successful scrutiny than Venus.

COMETS.—Perrine's periodic comet, 1896 VII. and 1909 III., should now be looked for in the moon's absence. The following ephemerides are on two assumptions of the time of perihelion:

Date. Greenwich Noon.	Assumed T., Oct. 3. R.A.	Decl.	Assumed T., Oct. 11. R.A.	Decl.
	h. m.		h. m.	
Oct. 19.0	7 45	19°·0 N.	7 19	24°·0 N.
27.0	8 5	14°·3	7 40	18°·7
Nov. 4.0	8 21	9°·6	7 56	13°·4
12.0	8 33	5°·1 N.	8 9	8°·1 N.

Search should be made near the line joining the two positions for each date.

Mr. Wood sends the following elliptical orbit of comet 1922 *a*:

EPOCH 1922, JAN. 1.0.

M	0° 2′ 1″
ω	183° 37′ 32″
Ω	274° 30′ 13″
i	32° 30′ 16″
log e	9·9953713
log a	2·1874524
μ	1″·857

Period about 1900 years.

Mr. Wood is at work on a more exact orbit, using photographic positions that extend to April 25 last.

THE MASSES OF VISUAL BINARY STARS.—The *Astronomical Journal*, No. 807, contains measures of the parallaxes of several binary stars made photographically at the Sproul Observatory by Messrs. J. A. Miller and J. H. Pitman. Investigation was made as to how far the irregularity of the combined image and the change in relative positions due to orbital motion between the exposures might introduce error. The probable errors seem to be quite as small as for single stars. The parallaxes deduced by other observers are tabulated as well as their own, and masses are deduced and classified according to spectral type with the following results for average mass: B 14·91; A 3·49; F 3·92; G 1·77; K 1·57; M 0·65. Only two M stars were available.

In conclusion, the advisability is pointed out of obtaining absolute parallaxes of as many binaries as possible by the relative shift of spectral lines due to different motion of the components in the line of sight. The method has already been applied to Alpha Centauri and to Castor, also to Sirius (bright star only). A list is given of 18 stars to which the method might be applied, with the amount of present and maximum differential motion. It is necessary either that both spectra should be visible or that the relative masses should be known.

Research Items.

GYPSY FOLKLORE.—The new series of the Gypsy Lore Society's Journal is being actively conducted by its energetic secretary, Mr. T. W. Thompson. The last issue (Third Series, vol. i., part 3) contains an excellent article by him on the Gypsy Grays as tale-tellers, which describes the methods by which the incidents of their stories are manipulated. This has a much wider interest than is implied by its title, and students of folk tales will find that it throws much needed light on the construction of these narratives.

HOCKEY IN ANCIENT GREECE.—An ancient Greek sculptured relief recently discovered in Athens, according to the *Times*, gives evidence that the Greeks played ball games other than with the hand. The relief represents six naked youths taking part in a game bearing every resemblance to modern hockey. The curved stick used may possibly supply an explanation of the singular curved object carved in relief on some of the votive offerings found at Sparta. These have been called "sickles." It is difficult to say why this implement should have been dedicated to Artemis, but the word "sickle" may have been the current slang for a boy's hockey-stick.

ROMAN REMAINS IN LONDON.—Recent excavations in the City have led to important discoveries. It seems to be proved that the ancient church of St. Peter's-upon-Cornhill was built inside of what was once a Roman fortress, which future investigation is expected to show was the first fortified camp of the Romans. If so, it is possible that it was built immediately after the re-establishment of order subsequent to the revolt of Boadicea. Mr. W. C. Edwards, the archæologist in charge of these investigations, believes that during the next ten years more Roman discoveries will probably be made in the City than have been made for centuries. The excavation recently struck what is probably the most ancient wall yet found in London. At one point it is 5 feet thick, and above the footings were courses of tiles, four abreast, each 13 inches broad. Rooms were added to it with plastered walls which appear to be of imitation alabaster, the wall being overlaid with a layer of white cement, almost as thin as paper, on which designs had been painted by a very skilful artist. It is now clear that Gracechurch Street was not Roman: it probably belongs to Saxon times, and was the work of Alfred the Great.

ARCHÆOLOGY IN PALESTINE.—Among the obligations undertaken by Great Britain in connexion with the control of Palestine is that of promoting archæological research. It was a condition of the scheme that in the Advisory Board for Archæology other nations should be represented. The first work which will now be undertaken is the excavation of the ancient City of David on Mount Ophel, immediately south of the existing walls of Jerusalem. Three different attempts have been made to probe the secrets of the hill, and though attended with some measure of success, practically the whole of Jebus, the original stronghold, the Palace and Millo of David, and in all probability the tombs of the Kings of Judah, await investigation. An area of ten acres has been preserved by the Administration, and this is now available for excavation. East of Jordan an immense field remains practically untouched, and many of these sites are of importance equal to that of Palestine itself. Especially at Jerash, the ancient Gerasa, there are wonderful remains of the Roman city, which show that it was one of the most imposing cities of the Roman period. The excavation of these Palestine sites is likely to throw welcome light not only on the history of the Hebrews but on the obscure annals of the nations who preceded them, and it may be hoped that the Palestine Exploration Fund, which counts among the names of its illustrious servants that of Kitchener, will receive adequate support in carrying out the well-arranged programme of investigation which is now laid before the scientific world.

UPPER CRETACEOUS GASTROPODS OF NEW ZEALAND.—Certain Upper Cretaceous gastropods of New Zealand, originally referred to Mr. H. Woods for description, were on his recommendation forwarded to Dr. O. Wilckens, then at Strasbourg, to deal with. The intervention of the war and consequent removal of Dr. Wilckens to Bonn delayed the completion of the task, and the finished monograph as rendered into English by the author himself has recently been issued as Palæontological Bulletin No. 9 by the Geological Survey Branch of the New Zealand Department of Mines. The major portion of the fossils studied are of Upper Senonian age. While these include a few species peculiar to New Zealand, resemblances can be traced in many examples to species from beds of equivalent age in North Germany, Chili, Patagonia, the Antarctic Regions, and South India. Of the indigenous forms the most striking is the remarkable *Conchothyra parasitica*, and Dr. Wilckens gives a very careful account of its strange growth and development. The plates accompanying the monograph are deserving of much praise, and there is a map showing the localities whence the fossils were obtained.

MARINE FOSSILS IN CENTRAL INDIA.—The General Report of the Geological Survey of India for 1921 contains a confirmation, and some further particulars, of the discovery of marine fossils in the lower Gondwana series of Central India, which was reported in some of the Indian newspapers about nine months ago. The discovery, which was made by Mr. K. P. Sinor, State Geologist to the Rewah Durbar, at Umaria, situated almost centrally in the broadest part of the Peninsula, consists of a shell band, about 3 inches thick, composed almost entirely of shells of the genus Productus. Below the shell band are quartz grits which pass up, through the band, conformably into sandstones of Lower Barakar age, the bed itself lying not far from the junction of the Gondwana rocks with the underlying gneiss, in beds which are usually regarded as of Talchir age. The discovery has been further investigated by Mr. P. N. Mukherji, field collector of the Survey, who added two specimens of Spiriferina to the fauna. The Productus has not yet been identified, but it is new to India; the Spiriferina is close to, and probably identical with, *S. cristata*, var. *octoplicata*. The fossils, therefore, are not of great assistance in determining the precise age of the band, but the discovery of marine conditions in the centre of the Peninsula, where no marine rocks of later than probably pre-Cambrian age had previously been found, is of great interest and importance. Dr. L. L. Fermor, the officiating director, by whom the report is made, discusses the question of whether the sea lay mainly to the north, or the west, of the newly discovered Productus locality. In either case the discovery, though of interest as marking a greater extension of the sea than had been previously suspected, does not materially alter the conclusion that the Indian Peninsula is a region which has been continuously dry land throughout the whole period covered by the sequence of fossiliferous rocks.

THE DISTRIBUTION OF TEMPERATURE IN SCANDINAVIA.—The Meteorological Institute of Sweden has published an important paper and series of charts by Mr. H. E. Hamberg on thermosynchrones and thermoisochrones in the Scandinavian peninsula (*Bihang till Meteorologiska lak ttagelser, Bd.* 60, 1918 (1922)). In tables and charts, founded on the observations of 232 Swedish and 83 Norwegian stations, Mr. Hamberg gives the mean annual dates at which certain temperatures reign. The temperatures are reduced to sea-level for this purpose, although Mr. Hamberg fully realises that for certain geographical uses the value of the charts is thereby lessened, and he gives two pairs of charts, spring and autumn, one for 12° C. and the other for 0° C., in which the actual temperatures are utilised. A second series of charts indicates the average number of days with a temperature above or below certain figures. The curves on these charts Mr. Hamberg terms thermoisochrones. The charts, which are small but very clear, are most useful for geographical purposes.

SPELL OF WARM WINTERS IN EUROPE.—The abnormal winter warmth recently experienced in Central Europe, embracing England, is dealt with in the *Meteorological Magazine* for September by Mr. C. E. P. Brooks, of the Meteorological Office. A chart is given showing the differences of the mean temperatures for the winter, comprised by the months December, January, and February, for the years 1911 to 1920, and the long period averages for the combined winter months, mostly covering the years 1851 to 1910. At Budapest the winters of the past ten years have on the average been more than 4° F. warmer than the normal winter. At Zürich the excess is 2°·6 F.; at Paris, 2°·1 F.; and at Kew, 1°·8 F. On the Atlantic sea-board the winters of the decade in question have been slightly colder than the normal. There is no appreciable difference of temperature for the rest of the year, the summer months for the years 1911 to 1920 having been, on the whole, somewhat cooler than the average. The abnormal warmth of the winters was not confined to low levels; the mean winter temperature for the ten-year period at St. Gothard, 6877 feet above sea-level, is 1°·9 F. above the normal. The author suggests a tentative explanation connecting the abnormal warmth with the general decrease of sunspot numbers since the nineteenth century. Taking the mean winter temperature at Greenwich for the ten-year period, 1911 to 1920, it is 1°·5 F. above the 60 years' average, and the mean was above the normal in 8 winters out of 10, the excess being more than 3° F. in 4 winters. In the ten-year period from 1886 to 1895 the mean winter temperature at Greenwich was 1°·9 F. below the normal for sixty years, and in 8 winters out of 10 the mean was below the average, the deficiency amounting to 3° F. or more in 3 winters; this is a different period from that given by the author and with an opposite effect.

GLARE FROM MOTOR HEADLIGHTS.—The descriptions of motor headlights exhibited at the meeting of the Optical Society on May 11 will be found in part 4 of volume 23 of the Transactions of the Society, together with a report of the discussion of the conditions which a satisfactory headlight should fulfil. In America these conditions are that 100 feet ahead of the car at a point 5 feet above the horizontal, the illumination must not exceed that due to a lamp of 750 candle power. The conditions laid down in this country by the Ministry of Transport relate to the width and height of the beam and place no restriction on its intensity. The reconciliation of the requirements of the driver and the pedestrian or driver he is approaching is difficult, but the general opinion of those who took part in the discussion appeared to be that the beam should have a candle power of 3000 in a direction half a degree below the horizontal and be reduced to 500 or 600 candle power in a direction one degree above the horizontal. As the glare effect is due to contrast, it was further suggested that the car body and the road at the side of the car should be illuminated to some extent as well as the road in front.

A NEW THEORY OF VISION.—A photo-electric theory of vision has recently been put forward by Dr. F. Schanz of Dresden and has been discussed in the *Zeitschrift für Augenheilkunde*. At present it is incomplete, but according to a paper in vol. 54 of the *Zeitschrift für Sinnesphysiologie* the author hopes to fill in the gaps by work on which he is at present engaged. In outline it is as follows: Light on entering the eye is absorbed by the visual purple, which as a result emits electrons at speeds which depend on the wave-length but not on the intensity of the incident light; that is, the visual purple is photo-electric. The electrons impinge on the rods and cones and produce the sensation of light. If their velocities do not differ widely they are equalised during their passage to the rods and cones and produce a single sensation corresponding to the mean velocity; but if they differ materially the interval between their emission and their arrival at the rods and cones is not sufficient to equalise them and they produce distinct sensations. Over a range of wave-lengths of 1×10^{-4} cm. equalisation is produced, but if all wave-lengths over a range double this are present, the sensation of white is produced, whether the range be *e.g.* from 4 to 6 or from 6 to 8×10^{-4} cm.

TESTING FOR VITAMINS.—Investigators are searching actively for some chemical means of recognising the presence of the vitamins in food materials, and the discovery of such a test would enormously increase the facility of research on these elusive substances. So far all the suggestions made have failed to withstand a critical examination. In a recent paper in the *Analyst*, Messrs. Drummond and Watson point out the close relation which exists between the presence of vitamin A in fats and the well-known reaction given by liver oils, which consists in the production of a purple coloration when the oil is dissolved in an organic solvent and a drop of sulphuric acid is added. All the liver oils of mammals, birds, and fish examined by the authors gave the reaction, but they also find that it is given, although less strongly, by the body fat of some animals and by butter. In striking agreement with the behaviour of vitamin A, the power of producing the coloration is lost when a current of air is passed through the fat at 100° C. but not when the fat is heated at this temperature in absence of air. Again, when the fat is hydrolysed it remains, with the vitamin A, in the unsaponifiable fraction. Moreover, the intensity of the reaction was found to be roughly proportional to the vitamin A content of a series of fish-liver oils. The livers and fat of pigs and rats fed on diets deficient in vitamin A did not give the reaction, but this reappeared when the deficiency was made good. It is obvious that there is a close parallel between the two properties, and the authors, without claiming that the test actually indicates the presence of the vitamin, suggest "that the association may be of some significance." The necessity for this caution is indicated by the facts that although the marine diatom Nietzschia has been shown to be rich in vitamin A the oil extracted from this organism did not give the purple colour test with sulphuric acid. A similar negative result was obtained with plankton oil, although the reaction was given by certain marine algæ.

Tendencies of Modern Physics.

THE Swiss Society of Natural Sciences met this year at Berne on August 24 to 27. The programme of the session comprised several discussions on questions of general interest, and papers of a more special character communicated to the various sections. The work was divided between the following sections: (1) Mathematics; (2) Physics; (3) Geophysics, Meteorology, and Astronomy; (4) Chemistry; (5) Geology, Mineralogy, and Petrography; (6) Botany; (7) Zoology; (8) Entomology; (9) Palæontology; (10) Anthropology and Ethnology; (11) Medical and Biological Science; (12) History of Medicine and Natural Science; (13) Veterinary Science; (14) Pharmacy; (15) Engineering History.

We cannot give here a detailed account of this annual event in Swiss science; we shall therefore confine ourselves to a résumé of the address of Prof. C. E. Guye, of Geneva, in opening the series of general discussions.

Taking the title, "The Tendencies of Modern Physics and the Conception of Matter," Prof. Guye first showed that modern physics was becoming more and more electromagnetic, discontinuous, and statistical. To these three characteristics, which have been sufficiently disconcerting to minds accustomed to the classical conceptions of the second half of the nineteenth century, there has now been added a fourth, of still more perplexing character, in the introduction of the principle of relativity. In adopting this principle physics has displayed a distinctly metaphysical tendency, which sometimes ventures to introduce into scientific discussion a dogmatic method of procedure. It is true that the difficulty is compensated by important advantages, resulting from the fact that the formulæ of relativity introduce more simplicity in the dynamics of very great velocities, and more unity between the various branches of physics.

After having shown how physics, like chemistry, has moved steadily along the path of discontinuity by the introduction of the atom of electricity and the theory of quanta, Prof. Guye spoke of the consequences of this discontinuity, which complicated greatly the explanation of phenomena apparently of the most simple character.

How, indeed, could one follow, by means of the equations of mechanics, the reciprocal actions of a nearly innumerable group of discontinuous elements (molecules, atoms, electrons)? This extreme complication which characterises the phenomenon, apparently so simple, when it is desired to study it intimately, led to the introduction of kinetic theories. The calculus of probabilities then came to the aid of physicists, powerless as they were to solve, by means of the equations of mechanics, the inextricable problems which were proposed to them. But the consequence of these kinetic theories is to lead us to conceive physico-chemical laws as statistical, so that we must picture physico-chemical determinism as a statistical determinism, to which the law of great numbers imparts all the appearance of infinite precision.

The progress of physics towards electromagnetism is particularly striking. The first decisive step along this path was made by Maxwell, to whom we owe the electromagnetic theory of light, which, universally accepted as it is to-day by physicists, unites in a systematic whole the phenomena of light and of electromagnetism. But this tendency to explain physical phenomena by the laws of electromagnetism has only served to make it still more accentuated. It has even attacked the mechanics which seemed to be the immutable basis of the old physics. To-day the fundamental postulate of mechanics—inertia—can be satisfactorily explained in terms of the properties of an electromagnetic field, and more and more intermolecular forces appear to be of electromagnetic nature (Debye, Keesom).

But the main reason for this constant evolution of physics towards electromagnetism is the work carried out particularly in England (Rutherford's school), which has exhibited it in a most convincing fashion. The material atom itself appears to be constituted entirely of charges of electricity, positive and negative (electrons), and all physical forces, with the exception of the mysterious force of gravitation, will thus be found, in the last resort, to be electric and magnetic forces.

In the second part of his address, Prof. Guye showed how the conception of matter, as defined by inertia, had evolved from Lavoisier to Einstein, and to the most recent work of Rutherford and Aston. Without committing ourselves positively to Prout's hypothesis, which would make the atomic weights of the elements integral multiples of that of a unique constituent—the atom of hydrogen—new developments point to a duality of ultimate material, the positive electron which is mainly responsible for the inertia of the atom, and the negative electron.

In short, the startling progress realised in physics during the last thirty years has reduced to naught all those fluid phantoms which we knew—imponderable electric and magnetic fluids; only the most tenacious among them—the aether—offers still a partial resistance.

Physicists have thus been led, little by little, to the idea of the materiality of electricity, and still more the formulæ of relativity point to the parallelism between inertia and energy; that is, to the fusion into a single principle of the two principles which govern all physical phenomena—the principle of the conservation of mass and that of the conservation of energy.

Such are the important results, not only from the scientific point of view, but also from that of our best philosophic culture, which modern research has brought forward during the course of the last thirty years.

The Isothermal Frontier of Ancient Cities.[1]

THE northern frontier of the Roman Empire is shown in atlases of ancient geography, and that of the Achæmenian Empire of the Persians and of the dynasties which succeeded in the Middle East. The frontier of the ancient Chinese Empire has not been made similarly familiar, and in place of it there is the representation of the Empire of China as it has been in mediæval and modern times. From this most of Manchuria, all Mongolia, and the Ili valley must be shorn off in order to get the Chinese northern frontier as it was under the Han dynasty in the beginning of the second century after Christ, the age of the Antonines in Europe. At this time, when the ancient civilisation of Eurasia was at the height of its culture and apparently at the maximum of its power, the northern frontier once controlled by

[1] Abstract of a paper by Dr. Vaughan Cornish read before Section E (Geography) of the British Association at Hull on Sept. 12.

the Persian Achæmenidæ was divided between the Parthians, capitalled at Ctesiphon, and the Kushan dynasty of the Yue-chi, capitalled at Peshawar. These four northern frontiers, Roman, Parthian, Kushan, and Chinese, were consecutive, forming an unbroken line from the mouth of the Rhine near the modern Katwyk in Holland, 52° N., to the east coast of Korea in about 41° N. South of the line a vast array of established cities stretched for seven thousand miles across Eurasia, in some parts protected by natural barriers, in others defended by lines of masonry fortification. North of the line were the tents of nomads, huts of forest dwellers, and stockaded defences of earth and wood. In the northern part of modern Germany there were territories north of the line which the Romans had abandoned as untenable or unprofitable. South of the line in Eastern Europe was the district of Dacia which Augustus preferred not to touch, but Trajan was compelled to occupy. In this country the native people had in the interval begun to construct masonry fortifications.

In the course of an investigation of the geography of capital cities, it was found that this northern frontier of ancient cities, on the eve of the barbarian irruption, has, within narrow limits of variation, the same average temperature throughout. It is a true annual isotherm, not an isotherm reduced to sea level. Along the European part is a line of modern cities with meteorological observatories. The annual temperatures of eight of these, strung out along the length, has an average of 48°·6 F. Asia is not well off for meteorological records near the line on the south, and the second table consists of a list of towns mostly under Russian rule just north of the line where proper records have been kept. It will be observed, therefore, that their temperatures are rather lower than that along the frontier of the ancient cities. The average temperature of these eight towns north of the line is 47°·4 F. A very long gap in these towns occurs between Kuldja and Mukden, but the record for the Lukchun depression in Chinese Turkestan, a little south of the frontier yields a not inconsistent figure, if corrected for the general height of the surrounding country, and that of Peking is not discordant. Further east the generalised isotherm of 48°·5 F. reaches the eastern coast of Korea in about 41° N. (somewhat north of the peninsula portion of the country) which cannot be very far from the frontier of its ancient cities.

In the detached Roman possession of Britain the inner and principal line of fortification had its western terminal at Carlisle, where the temperature is 47°·8 F. Eastwards of the continent of Eurasia the conquest of the Japanese islands by their present masters was only completed at a much later date than that under consideration, but the Japanese derived their culture from ancient China (mainly through Korea) and it may therefore be significant that they were content to conquer, without colonising, Yezo, the northern island, and that what is reckoned by the Japanese as Japan proper, and is called by them "Old Japan" does not include Yezo but stops short with Honshiu, the mainland, and that the annual isotherm of 48°·5 F. traverses the strait of Tsugaru which separates Old Japan from Yezo.

The fact that the annual temperature along this immense line only varies within remarkably narrow limits cannot be reasonably contested. If it be the case that desiccation has occurred generally in Asia along this line since the second century of our era its probable effect would be to lessen the winter and raise the summer temperature, leaving the annual temperature much the same.

The coincidence of frontier and true isotherm is not a mere consequence of east and west barriers of mountains, inland seas, and rivers, for these had to be supplemented by long lines of fortification. Neither was it due to unsuitability of the southern country to pastoral peoples, for in Asia there was much coveted grazing land south of the settled frontier. Precisely how far this coincidence is significant it is yet difficult to say.

Annual Temperatures along the Frontier in Europe.		Annual Temperatures north of the Frontier in Asia.	
	° F.		° F.
Carlisle	47·8	Stavropol	47
Utrecht	47·8	Astrachan	50
Cologne	50·2	Kazalinsk	46·5
Ratisbon	46·6	Aulieata	51·5
Vienna	48·8	Narynsk	44
Buda-Pesth	49·8	Vyerni	46·5
Debreczin	49·3	Kuldja	48·5
Odessa	48·5	Mukden	45
Mean	48·6	Mean	47·4

The Mechanism of the Cochlea.

MOST medical students have probably felt that current physiological teaching provided them with only a hazy conception of the mechanism for hearing in the cochlea. Helmholtz put forward the view that this organ contained a series of resonators, which were differentiated like a set of piano strings, so that each string vibrated only in response to one particular note. It will be remembered that the cochlea forms a spiral, which when unwound consists of two chambers, placed one above the other, and separated by the basilar membrane. At one end (the base) of the cochlea, in the wall of the upper chamber, is the window which is set in vibration by the middle ear, while in the wall of the lower chamber is a similar window whose function is to prevent the pressure from changing inside the cochlea when the upper window moves. Both chambers contain fluid, and, at the other end (the apex) of the cochlea, the chambers unite, for the basilar membrane ceases just short of the apex.

The suggestion that the fibres of the basilar membrane can act as a resonating system has been current since it was pointed out that their length (measured across the canal) varied continuously from the base to the apex. Now the fibres of a resonating system must obey the laws which govern vibrating strings, so that n, the number of vibrations of a string per sec., $=\frac{1}{2l}\sqrt{\frac{t}{m}}$, where l is the length of a fibre, t is the tension, and m is the mass per unit length. Gray showed in 1900 that the tension of the fibres of the basilar membrane also varied from the base to the apex, for while the spiral ligament which attached the membrane to the outer wall of the cochlea was very dense near the base, it was, on the contrary, very slender near the apex. We know, therefore, that the fibres of the basilar membrane are differentiated for tension and length, so that the short fibres near the base are under high tension, and the long ones near the apex are under low tension. To complete the requirements of the formula for vibrating strings, it is only necessary to discover a system by which the fibres are differentiated for mass, which differentiation must, as the formula

demands, be applied so that the load on the fibres is small near the base, but large near the apex.

A great difficulty in supposing that the basilar membrane represents a system of resonating strings is the fact that it is immersed in fluid. It is precisely this point which Dr. George Wilkinson, in a paper read before the Section of Physiology of the British Association at the recent Hull meeting, conceives to be, not a difficulty, but the key of the whole problem. He suggests that the differentiation of the fibres as to mass, or the "loading" of the fibres, is brought about by the fluid in the canals. When the fibres at any point of the membrane vibrate in response to an impulse from the middle ear, they will be loaded by the weight of a column of fluid proportional to the distance of the vibrating point from the *fenestra rotunda*, which is the window between the cochlea and the middle ear. The column of fluid between the window and the vibrating point will be least in the case of a point on the membrane near the base of the cochlea, and greatest in the case of a point near the apex.

So much for Dr. Wilkinson's theoretical conception. He has provided a convincing proof of his views in the shape of two very ingenious models. The first is a brass box divided horizontally into two like the cochlea unwound from its spiral. The partition which represents the basilar membrane consists of a series of parallel wires of phosphor-bronze soldered firmly in position, and covered with formalised gelatin. On this basilar membrane is scattered blue enamel powder. There is a *fenestra rotunda* and *ovalis* at one end of the box, respectively above and below the basilar membrane, the windows being formed in each case by a rubber disc. The box is filled with water and is completely closed. In his first model, Dr. Wilkinson has kept all his phosphor-bronze wires at the same tension and of the same length. Yet he finds that when he applies a vibrating tuning-fork to the rubber membrane, or *fenestra rotunda*, the powder on the basilar membrane takes up a definite position which varies with tuning-forks of different rates of vibration. Thus a 200 D.V. fork produces a localised resonant response at a distance 3·3 cm. from the proximal end of the scale, while a 400 D.V. fork produces such a response at a distance of 0·9 cm. If one makes use of the formula for vibrating strings and supposes that the differentiation in resonance is due to the different loading of the wires by the fluid according to the above hypothesis, then the point of resonance to the lower tone should be 4 times the distance from the windows compared with that for the upper tone. Actually we see that it is not 4 times, but is $3{\cdot}3/0{\cdot}9 = 3{\cdot}6$ times. A very striking agreement!

Here then is proof of Dr. Wilkinson's contention that a system of transverse fibres, immersed in a fluid as it is in the cochlea, is already, by reason of the position of the *fenestræ*, differentiated for resonance in regard to the effective mass of the fibres.

In his second model, which is larger, he has carried out a differentiation of his phosphor-bronze wires in respect of tension and length. The differentiation of tension is effected by attaching weights of different sizes to the ends of the individual wires; while the lighter weights are attached to the longer fibres near the "apex," the heavier weights are attached to the shorter fibres near the base. In this way he has attained a model which gives a localised resonant response over a range exceeding four octaves.

One may say in conclusion that Dr. Wilkinson has made a very considerable contribution to our knowledge of the mechanism of hearing, and has presented the first clear conception of how the cochlea can work.

British Association Research Committees.

RESEARCH committees to deal with the following subjects were appointed by the General Committee at the recent meeting of the British Association at Hull. The names given are those of the chairmen and secretaries of the committees.

SECTION A (MATHEMATICS AND PHYSICS).—Seismological investigations: Prof. H. H. Turner, Mr. J. J. Shaw. To assist work on the tides: Prof. H. Lamb, Dr. A. T. Doodson. Annual tables of constants and numerical data, chemical, physical, and technological: Sir Ernest Rutherford, Prof. A. W. Porter. Calculation of mathematical tables: Prof. J. W. Nicholson, Dr. J. R. Airey. Determination of gravity at sea: Prof. A. E. H. Love, Prof. W. G. Duffield. Investigation of the upper atmosphere: Sir Napier Shaw, Mr. C. J. P. Cave. To aid the work of establishing a solar observatory in Australia: Prof. H. H. Turner, Prof. W. G. Duffield.

SECTION B (CHEMISTRY).—Colloid chemistry and its industrial applications: Prof. F. G. Donnan, Dr. W. Clayton. Absorption spectra and chemical constitution of organic compounds: Prof. I. M. Heilbron, Prof. E. C. C. Baly.

SECTION C (GEOLOGY).—The Old Red Sandstone rocks of Kiltorcan, Ireland: Prof. Grenville Cole, Prof. T. Johnson. To excavate critical sections in the palæozoic rocks of England and Wales: Prof. W. W. Watts, Prof. W. G. Fearnsides. The collection, preservation, and systematic registration of photographs of geological interest: Prof. E. J. Garwood, Prof. S. H. Reynolds. To consider the preparation of a list of characteristic fossils: Prof. P. F. Kendall, Mr. H. C. Versey. To investigate the flora of lower carboniferous times as exemplified at a newly discovered locality at Gullane, Haddingtonshire: Dr. R. Kidston, Prof. W. T. Gordon. To investigate the stratigraphical sequence and palæontology of the Old Red Sandstone of the Bristol district: Mr. H. Bolton, Mr. F. S. Wallis.

SECTION D (ZOOLOGY).—To aid competent investigators selected by the committee to carry on definite pieces of work at the Zoological Station at Naples: Prof. E. S. Goodrich, Prof. J. H. Ashworth. To summon meetings in London or elsewhere for the consideration of matters affecting the interests of zoology, and to obtain by correspondence the opinion of zoologists on matters of a similar kind, with power to raise by subscription from each zoologist a sum of money for defraying current expenses of the organisation: Prof. S. J. Hickson, Dr. W. M. Tattersall. Zoological bibliography and publication: Prof. E. B. Poulton, Dr. F. A. Bather. Parthenogenesis: Prof. A. Meek, Mr. A. D. Peacock. To nominate competent naturalists to perform definite pieces of work at the Marine Laboratory, Plymouth: Prof. A. Dendy (*Chairman and Secretary*). Experiments in inheritance in silkworms: Prof. W. Bateson, Mrs. Merritt Hawkes. Experiments in inheritance of colour in Lepidoptera: Prof. W. Bateson (*Chairman and Secretary*).

SECTION E (GEOGRAPHY).—To consider the advisability of making a provisional population map of the British Isles, and to make recommendations as to the method of construction and reproduction: Mr. H. O. Beckit, Mr. F. Debenham.

SECTIONS E, L (GEOGRAPHY, EDUCATION).—To

formulate suggestions for a syllabus for the teaching of geography both to matriculation standard and in advanced courses; to report upon the present position of the geographical training of teachers, and to make recommendations thereon; and to report, as occasion arises, to Council, through the Organising Committee of Section E, upon the practical working of regulations issued by the Board of Education affecting the position of geography in training colleges and secondary schools: Prof. T. P. Nunn, Mr. W. H. Barker.

SECTION G (ENGINEERING).—To report on certain of the more complex stress distributions in engineering materials: Prof. E. G. Coker (*Chairman*), Prof. L. N. G. Filon, and Prof. A. Robertson (*Secretaries*).

SECTION H (ANTHROPOLOGY).—To report on the distribution of Bronze Age implements: Prof. J. L. Myres, Mr. H. J. E. Peake. To conduct archæological investigations in Malta: Prof. J. L. Myres, Sir Arthur Keith. To conduct explorations with the object of ascertaining the age of Stone Circles: Sir Hercules Read, Mr. H. Balfour. To excavate early sites in Macedonia: Sir William Ridgeway, Mr. S. Casson. To report on the classification and distribution of rude stone monuments: Dr. R. R. Marett, Prof. H. J. Fleure. The collection, preservation, and systematic registration of photographs of anthropological interest: Sir Hercules Read, Mr. E. N. Fallaize. To conduct archæological and ethnological researches in Crete: Dr. D. G. Hogarth, Prof. J. L. Myres. To co-operate with local committees in excavation on Roman sites in Britain: Sir William Ridgeway, Mr. H. J. E. Peake. To report on the present state of knowledge of the ethnography and anthropology of the Near and Middle East: Dr. A. C. Haddon, Mr. E. N. Fallaize. To report on the present state of knowledge of the relation of early palæolithic implements to glacial deposits: Mr. H. J. E. Peake, Mr. E. N. Fallaize. To investigate the lake villages in the neighbourhood of Glastonbury in connexion with a committee of the Somerset Archæological and Natural History Society: Sir William Boyd Dawkins, Mr. Willoughby Gardner. To co-operate with a committee of the Royal Anthropological Institute in the exploration of caves in the Derbyshire district: Sir William Boyd Dawkins, Mr. G. A. Garfitt. To investigate processes of growth in children, with the view of discovering differences due to race and sex, and further to study racial differences in women: Sir Arthur Keith, Prof. H. J. Fleure. To conduct excavations and prepare a survey of the Coldrum megalithic monument: Sir Arthur Keith, Prof. H. J. Fleure. To report on the existence and distribution of long-barrows in the Isle of Man: Prof. H. J. Fleure, Dr. Cyril Fox. To report on proposals for an anthropological and archæological bibliography, with power to co-operate with other bodies: Dr. A. C. Haddon, Mr. E. N. Fallaize. To report on the best means of publishing a monograph by Dr. Fox on the archæology of the Cambridge region: Dr. A. C. Haddon, Mr. H. J. E. Peake.

SECTION I (PHYSIOLOGY).—Efficiency of movement in men equipped with artificial limbs: Prof. E. P. Cathcart, Prof. A. V. Hill. Muscular stiffness in relation to respiration: Prof. A. V. Hill, Dr. Ff. Roberts.

SECTION J (PSYCHOLOGY).—The place of psychology in the medical curriculum: Prof. G. Robertson, Dr. W. Brown. Vocational tests: Dr. C. S. Myers, Dr. G. H. Miles.

SECTION K (BOTANY).—To continue breeding experiments on Œnothera and other genera: Dr. A. B. Rendle, Dr. R. R. Gates. Primary botanical survey in Wales: Dr. E. N. Miles Thomas, Prof. O. V. Darbishire.

SECTION L (EDUCATIONAL SCIENCE).—Training in citizenship: Rt. Rev. J. E. C. Welldon, Lady Shaw. To inquire into the practicability of an international auxiliary language: Dr. H. Foster Morley, Dr. E. H. Tripp.

University and Educational Intelligence.

BIRMINGHAM.—The University War Memorial, which was unveiled on Sunday, October 8, takes the form of three large panels of marble, on the eastern side of the entrance hall of the University, bearing the names of members of the University who fell in the war.

The Muirhead lectures in social philosophy are to be delivered by Prof. J. H. Muirhead, who has chosen as his subject "The Idea of Progress." The first of the series of seven is to be given on October 16. The lectures are free.

CAMBRIDGE.—The Vice-Chancellor announces a legacy of 1000*l.*, free of legacy duty, to the Agricultural Department of the University by the will of the late Charles Jewell; by the will of the late Dr. Rivers books and pamphlets have been left to the library of St. John's College, and in addition 70 volumes have been selected for the library of the Psychological Department and 295 volumes for that of the Department of Ethnology.

Mr. W. J. H. Sprott, Clare College, has been appointed demonstrator in experimental psychology.

Mr. J. C. Burkill and Mr. A. E. Ingham have been elected Fellows of Trinity College.

It is proposed to confer an honorary M.A. degree on Prof. H. R. Dean.

LEEDS.—At a Congregation of the University held on Tuesday, October 10, the Duke of Devonshire, Chancellor of the University, presiding, the following honorary degrees were conferred: *Litt.D.*: The Lord Bishop of Ripon (The Rt. Rev. Dr. Thomas Banks Strong) and Mr. Bruce Richmond, Editor of the *Times Literary Supplement*. *D.Sc.*: Sir Dugald Clerk, Sir Frank Dyson, Astronomer Royal, and Sir Richard Gregory, Editor of Nature, president of the Educational Section of the British Association, 1922. *LL.D.*: Mr. H. I. Bowring, Mr. B. Broadbent, Mr. H. McLaren, and Mr. C. F. Tetley.

Sir Dugald Clerk was presented by Prof. Smithells, who said, "In him we welcome one who came to Leeds as a member of the first chemical staff of the Yorkshire College of Science, and he returns to-day a man eminent among his fellows as a great example of the ideal on which this University has spent so much of its early labours—the harmonious and fruitful union of pure and applied science."

In presenting Sir Frank Dyson, Prof. Whiddington referred to him as "the most distinguished British astronomer," who, they remembered with pride, is also a great Yorkshireman, and in his chosen field of work has been unvaryingly successful. "Every one knows him as the Astronomer Royal, a position which in these days of astronomical discovery he has filled with the highest distinction."

Prof. Smithells, in presenting Sir Richard Gregory, said: "He stands as one of the most distinguished of those who strive to interpret science to the multitude, to obliterate the false antagonisms that have arisen between the different realms of knowledge, and to win for science her rightful place among the potent influences that act for the true enlightenment and progress of mankind."

LONDON.—Dr. C. Da Fano will begin on Wednesday, October 25, at King's College, at 4.30, a course of eight free public lectures on "The Histology of the

Nervous System." The subsequent lectures will be given on November 1, 8, 15, 22, 29, and December 6 and 13. No tickets are required.

Dr. George Senter and Mr. C. W. Crook have been elected by the science graduates to fill the two vacant seats on the Senate.

SHEFFIELD.—The Council has appointed Prof. A. H. Leahy to be emeritus-professor of mathematics, and Mr. R. Platt to be demonstrator in pathology and bacteriology.

DR. A. J. SUTTON PIPPARD has been appointed professor of engineering at the University College of South Wales and Monmouthshire, Cardiff.

THE Loughborough Technical College has since 1918 developed a well-equipped faculty of engineering with departments of mechanical and civil, of electrical, and of automobile engineering. In its calendar for 1922–23 (price 3*s*. 6*d*.) it claims that its own workshops enable it to provide the student with all necessary practical training concurrently with his theoretical work, thus obviating the risk, incidental to sandwich systems, of forgetting in the works what was learned in the college and *vice versa*. The college is said to have at present more than 1500 full-time day students in residence. The governors include representatives of the universities of Birmingham and Cambridge, as well as of Leicestershire County Council and Loughborough Town Council.

THE Merchant Venturers' Technical College of Bristol, in which is provided and maintained the Faculty of Engineering of the University of Bristol, has issued for the session 1922–23 a calendar (price 6*d*.) with 18 full-page illustrations. Like the Royal Technical College, Glasgow, it is in touch with a number of engineering firms which co-operate with it in regard to the training of apprentices, but, whereas the former arranges its engineering courses in such a way as to leave student-apprentices free to spend in their firms' works the summers intervening between the winter sessions of the college, a special feature of the Bristol "sandwich scheme" is that the student spends in the works 14 months between the first and second college (10-months) sessions. Among the free-tuition entrance scholarships of the Merchant Venturers' College is one "for the son of a citizen of Béthune who has passed either the B.-ès-L. or B.-ès-Sc. examination."

THE administration of schools in the smaller cities of the United States of America is dealt with in an interesting and stimulating way in Bulletin No. 2 of 1922 of the Bureau of Education (Govt. Printing Office, Washington, D.C., price 10 cents). The statistical basis consists of answers by 520 superintendents of education to a *questionnaire*. From the section relating to teachers' qualifications it appears that the standard requirements as regards training for teaching in elementary and in high schools respectively are two years of normal-school work for the former and four years of college work with professional courses for the latter. The United States Chamber of Commerce has lately, in a pamphlet entitled "Know and Help your Schools," given currency to the view that the work of the elementary school in forming habits and ideals being as important as the work of any other school division, the elementary school teachers should be as well trained and well paid as those of the high school, but it does not appear that many school boards have as yet adopted this view.

Calendar of Industrial Pioneers.

October 22, 1915. Sir Andrew Noble died.—Widely known for his important researches on guns, projectiles and explosives, Noble was born in Greenock on September 13, 1831, and for some years served in the Royal Artillery. Joining Armstrong in 1860, he was for many years director of the ordnance works at Elswick and after Armstrong's death became the head of the great armament firm. His original investigations cover a period of fifty years, many of his memoirs being contributed to the Royal Society.

October 24, 1903. Samson Fox died.—The founder in 1874 of the Leeds Forge Company, Fox patented in 1877 his well-known corrugated furnace for steam boilers, the adoption of which led to the use of higher steam pressures. He first made pressed steel frames for railway wagons and was a pioneer of the acetylene industry.

October 25, 1684. Dud Dudley was buried.—Born in 1599, Dudley was a natural son of Edward Sutton, fifth Baron Dudley. Educated at Balliol College, Oxford, he was summoned home to superintend his father's iron works in Worcestershire, and in 1619 took out a patent for the use of pit coal instead of charcoal for smelting iron ore, an improvement in iron manufacture successfully used by Abraham Darby at Coalbrookdale in 1735. Dudley served as a colonel under Charles I. His work, "Metallium Martis," was published in 1665.

October 25, 1903. Robert Henry Thurston died.—A pioneer in engineering education in America, Thurston was trained as an engineer under his father and served in the navy during the Civil War. In 1870 he became professor of mechanical engineering in Steven's Institute, where he organised the first engineering laboratory in the United States; in 1880 he became the first president of the American Society of Mechanical Engineers. Removing in 1887 to Sibley College, Cornell University, he greatly extended the courses of instruction and by the time of his death the number of students had increased from 60 to 960. He was well known as a scientific investigator, and for his contributions to thermodynamics, steam engineering, and the strength of materials.

October 28, 1899. Ottmar Mergenthaler died.—The inventor of the linotype machine, Mergenthaler, who was born in Würtemberg on May 10, 1854, emigrated to America at the age of eighteen and worked as a watchmaker with his cousin in Washington. At Baltimore Mergenthaler came into contact with the reporter Clephane, and began work on a type printing machine which, after ten years and the expenditure of a million dollars, he at last brought to a successful issue. His linotype machine was first installed in 1886 in the composing room of the *New York Tribune*.

October 28, 1792. John Smeaton died.—The first "Civil Engineer" and the recognised father of his profession, Smeaton, like Watt, began life under an instrument maker in London. When in business for himself he gained a reputation by his scientific papers on wind power and other subjects. Though he constructed bridges and harbours he is known principally as the builder of the Eddystone lighthouse, an original work of great importance and utility which stood on the Eddystone rock from 1759 to 1882 and now forms a monument to Smeaton on the Hoe at Plymouth. Smeaton was a fellow of the Royal Society and in 1771 founded the Smeatonian Club for engineers. E. C. S.

Societies and Academies.

LONDON.

British Mycological Society (Keswick meeting), September 15-20.—F. T. **Brooks**: Some present-day aspects of mycology (presidential address). It is maintained that the fungi originated from protist organisms without direct relationship with the algæ, and developed upon novel lines as an entirely separate and characteristic group of plants. Arguments are advanced against the view that the fungi are phylogenetically related to the green and red algæ, or that they have been evolved from transmigrant seaweeds in ancient times. A monophyletic origin of the fungi is favoured. Most plant diseases are caused by fungi; hence there is need for closer co-operation between systematic mycologists and plant pathologists. Attention was directed to the inadequacy of the diagnosis of certain genera and species of pathogenic importance, and to the great influence of environmental conditions upon the growth of all kinds of fungal organisms. It is considered that mycologists and plant pathologists must be essentially botanists with the necessary fundamental training in chemistry and physics. For the plant pathologist a sense of crop values and of the important phases in the growth of crops should be inculcated.—Somerville **Hastings**: *Anellaria separata* growing in the Alps. The characters of these plants are related to the known conditions and compared with corresponding characters in phanerogams.—A. H. R. **Buller**: Luminosity in *Panus stypticus*. The mycelium and fruit body are both luminous, and by controlling the supply of oxygen the light can be turned on and off instantaneously. The light is given off even at or just below the freezing-point of water. Mycelium grown on wood blocks remained luminous for six months.—Miss E. M. **Wakefield**: Fungus-hunting in the West Indies. Observations were taken during six months spent in the Lesser Antilles and Trinidad. The characteristics of the fungus flora of these islands illustrate the distribution of fungi as affected by climate and the differences between tropical and temperate fungus floras in general.—Carleton **Rea**: Edible fungi; qualities from a gastronomic point of view of a number of the larger fungi.—M. C. **Potter**: Wart disease of potatoes. Preliminary experiments appear to indicate that the disease does not develop if the soil is rendered sufficiently alkaline (approximately PH 10·5).

MANCHESTER.

Literary and Philosophical Society, October 3.—Mr. T. A. Coward, president, in the chair.—T. A. **Coward**: Manchester birds, 1822-1922 (presidential address). One hundred years ago, 1822, John Blackwall, famous for his monograph on "British Spiders," read before this society a paper on "periodical" birds observed in the neighbourhood of Manchester. This list was enlarged by him in his "Researches in Zoology," and the dates of observation extended from 1814 to 1828 inclusive. Blackwall also published a list of singing-birds, and of rare visitors, and contributed to various journals notes on the habits of birds. His works prove that the local avifauna has changed but little in spite of the great increase of population and the extension of the city boundaries. A few species have vanished, others have appeared and colonised, and though few birds can now be seen in Ardwick "fields" the same species which used to occur may be met with in the parks or on the outskirts of the populated areas. The possession of open spaces, and the protection afforded by the city authorities to birds in the parks, have saved many birds from local extinction.

MELBOURNE.

Royal Society of Victoria, July 13.—Mr. Wisewould in the chair.—H. B. **Williamson**: Revision of the genus Pultenæa. Pt. III. Six new species are described: *P. Boormanii* from N.S.W., *P. Kenneyi* (Q.), *P. teretifolia* (S.A.), and three from Victoria—*P. D'Altonii*, *P. prolifera*, and *P. Readeriana*. A number of new varieties are discussed.—W. M. **Bale**: Two new species of Bryozoa. *Catenicella Matthewsi*: nearly allied to *C. alata* and *C. carinata*, differs from all known species in having the alæ throughout uncalcified, perfectly hyaline, and apparently structureless. Alæ wide, fenestræ about 12-14, small, with converging fissures. Avicularia minute, on long arm-like processes. According to Levinsen's system a Pterocella. *Claviporella Goldsteini*: very close to *C. aurita*, but without the large elliptic suboral pore. Fenestræ 3, minute but distinct, with well-marked fissures. This character distinguishes it from *C. imperforata* and *C. aurita*. (The same as *Catenicella McCoyi* Goldstein, *nomen nudum*, Jelly's "Synonymic Catalogue").—E. F. J. **Love**: Gravity determinations in Australia. By comparison of all existing material, very precise determinations of gravity for Melbourne and Sydney observatories have been obtained. Helmert's new theory of the figure of the earth—according to which the equator is slightly elliptical instead of truly circular—reconciles in great measure the observed and theoretical values of gravity at the Australian stations; there is a possible correlation between gravity at a station and the geological age of the neighbouring strata.

WASHINGTON.

National Academy of Sciences (Proc., vol. 8, No. 9, September 1922).—P. **Franklin**: The meaning of rotation in the special theory of relativity. Newtonian equations for rotation can be used to express first approximations for points near the axis of rotation. Making certain assumptions, it is shown that the spacial geometry for the rotating system depends on the time and space co-ordinates of the point considered, and that the curvature of the spatial cross-section at any space-time point in its "natural" co-ordinates is the square of the angular velocity in radians per light-second.—J. A. **Eldridge**: Energy losses accompanying ionisation and resonance in mercury vapour. Electrons emitted from an oxide-coated cathode traverse a region of constant potential in the experimental tube, suffering collisions with mercury vapour; they pass through two diaphragms, each pierced by a single hole, to the receiving electrode in the lower end of the tube, which is freed from mercury vapour by liquid air. A retarding potential is applied to the receiving electrode. The current is plotted against the retarding potential and it is shown that, at voltages above the ionisation point, the most important type of resonance collision involves an energy loss of 6·7 volts and also that a collision involving an energy loss of 5·7 volts occurs in mercury. In an ionising collision, the impinging electron apparently loses all its energy, and the electron produced leaves the parent atom with negligible energy.—L. W. **McKeehan**: Crystal structure of beryllium and beryllium oxide. Beryllium in the form of a loosely packed powder in a pyrex glass tube was submitted to X-rays from a molybdenum target. The oxide was treated similarly to detect lines due to oxide present as impurity. The fundamental space lattice for both element and oxide was found to be hexagonal.—J. P. **Minton**: Some cases of nerve-deafness and their bearing on resonance theories of audition. Curves are plotted

showing the relative receiver current in the testing apparatus necessary for the threshold of audition at various pitches. It is found that unless the nerve endings or the nerves are destroyed, hearing is normal if the tones are sufficiently intense. The internal ear mechanism lowers the threshold of audition but mechanical resonance of this structure is not responsible for tone perception.—C. **Lundsgaard** and D. D. **Van Slyke**: The quantitative influences of certain factors involved in the production of cyanosis. Cyanosis depends on the mean concentration of reduced hæmoglobin in the blood. It is shown mathematically that 40 per cent. of venous blood must be mixed with arterial blood to obtain the necessary concentration of reduced hæmoglobin. Cyanosis usually becomes perceptible when this concentration is 5 gms. per 100 c.c. of blood, but various influences may cause it to vary from 4-6 gms. per 100 c.c. of blood.

Official Publications Received.

Recueil de l'Institut Botanique Léo Errera. Tome 10, fascicule 2. Pp. 83-456. (Bruxelles: M. Lamertin.)

Canada. Department of Mines: Geological Survey. Summary Report, 1921, Part A. Pp. 121A. Summary Report, 1921, Part D. Pp. 110D. (Ottawa.)

Canada. Department of Mines: Geological Survey. Memoir 131, No. 112 Geological Series: Kenogami, Round, and Larder Lake Areas, Timiskaming District, Ontario. By H. C. Cooke. Pp. iv+64. (Ottawa.)

Sixtieth Annual Report of the Government Cinchona Plantations and Factory in Bengal for the Year 1921–22. Pp. 4+xii. (Calcutta: Bengal Secretariat Book Depot.) 8 annas.

Memoirs of the Indian Meteorological Department. Vol. 23, Part 5: On Cleaning and Refilling various Types of Barometer, together with a Description of several usual Patterns. By Dr. E. P. Harrison. Pp. 145-156+5 plates. (Calcutta: Government Printing Office.) 1·8 rupees; 2s.

Memoirs of the Indian Museum. Vol. 5: Fauna of the Chilka Lake. No. 10: The Hydrography and Invertebrate Fauna of Rambha Bay. By R. B. Seymour Sewell and Dr. N. Annandale. Pp. 679-710 +plates 32-43. (Calcutta: Zoological Survey of India.) 5 rupees.

1822 G. J. Mendel 1922. Herdenkingsnummer van Genetica. Nederlandsch Tijdschrift voor Erfelijkheids- en Afstammingsleer. Pp. 193-384. ('s Gravenhage: M. Nijhoff.) 8 gld.

Papers from the Geological Department, Glasgow University. Vol. 5: Octavo papers from 1918 to 1921. (17 papers.) Vol. 6: Quarto papers from 1915 to 1922. (15 papers.) (Glasgow: Maclehose, Jackson and Co.)

Report of the Danish Biological Station to the Board of Agriculture. xxviii., 1922. By Dr. C. G. Joh. Petersen. Pp. iv+103+5 Tables. (Copenhagen: G. E. C. Gad.)

Museums of the Brooklyn Institute of Arts and Sciences. Report upon the Condition and Progress of the Museums for the Year ending December 31, 1921. By William Henry Fox. Pp. 56. (Brooklyn, N.Y.)

University of Bristol. Calendar, 1922–23. Pp. 374. (Bristol.)

Proceedings of the Aristotelian Society. New Series. Vol. 22: Containing the Papers read before the Society during the Forty-third Session, 1921–1922. Pp. ii+242. (London: Williams and Norgate.) 25s. net.

Year Book of the Michigan College of Mines, 1921–1922, Houghton, Michigan. Announcement of Courses, 1922–1923. Pp. 127. (Houghton, Mich.)

Public Works Department, Government of India. Triennial Review of Irrigation in India, 1918–1921. Pp. viii+222. (Calcutta: Government Printing Office.) 5 rupees.

Records of the Survey of India. Vol. 15 (Supplementary to General Report 1919–20). Annual Reports of Parties and Offices, 1919–20. Prepared under the direction of Col. C. H. D. Ryder. Pp. 134+10 maps. (Calcutta: Survey General of India.) 4 rupees; 8s.

Cornell University Agricultural Experiment Station. Memoir 54: Horse Raising in Colonial New England. By Deane Phillips. Pp. 883-942. Bulletin 408: Production of new Strains of Corn for New York. By C. H. Myers, H. H. Love, and F. P. Bussell. Pp. 205-268. Bulletin 409: An Economic Study of Dairying on 149 Farms in Broome County, New York. By E. G. Misner. Pp. 269-444. Bulletin 410: Studies on Insects affecting the Fruit of the Apple; with Particular Reference to the Characteristics of the Resulting Scars. By Harry Hazelton Knight. Pp. 445-498+42 plates. (Ithaca, N.Y.)

Diary of Societies.

MONDAY, OCTOBER 23.

INSTITUTION OF MECHANICAL ENGINEERS (Graduates' Section), at 7.—R. D. Gauld: Some Factors in the Design of Steam Locomotives.

ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8.—W. R. Ackland: Some Considerations for Preventive Dentistry (Presidential Address).

TUESDAY, OCTOBER 24.

ROYAL SOCIETY OF MEDICINE (Medicine Section), at 5.30.—Dr. Newton Pitt: Presidential Address.—Major-Gen. Sir John Moore and others: Glanders and Anthrax.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—The Secretary: Report on the Additions made to the Society's Menagerie during the months of June, July, August, and September 1922.—Exhibition of Photographs of Zebras and Oryx from Kenya.—E. T. Newton: Exhibition of a Tanned Skin of a Frog.—R. H. Burne and Prof. J. P. Hill: The Fœtal Membranes of Chiromys. R. Kirkpatrick and Dr. J. Metzelaar: An Instance of Commensalism between a Hermit-Crab and a Polyzoon.

INSTITUTE OF MARINE ENGINEERS, INC., at 6.30.—Views Illustrating Industrial Works: Messrs. Bruce Peebles.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 8.—E. W. Mellor: Some Landmarks of Ancient Egypt.

WEDNESDAY, OCTOBER 25.

NEWCOMEN SOCIETY (at 17 Fleet Street), at 5.—E. A. Forward: Simon Goodrich and his Work as an Engineer. Part I. 1796–1810.

FELLOWSHIP OF MEDICINE (at 1 Wimpole Street), at 8.30.—Dr. E. Pritchard: The Feeding of Infants from Birth to the End of the Second Year.

THURSDAY, OCTOBER 26.

CHEMICAL SOCIETY (at Institution of Mechanical Engineers), at 8.—Sir W. H. Bragg and Prof. W. L. Bragg: The Significance of Crystal Structure.

ROYAL SOCIETY OF MEDICINE (Urology Section), at 8.30.—Sir John Thomson Walker: Relation of Calcified Abdominal Glands to Urinary Surgery (Presidential Address).

FRIDAY, OCTOBER 27.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Geophysical Discussion on the Maintenance of the Earth's Electric Charge. Chairman: Sir W. H. Bragg. Speakers: Dr. G. C. Simpson, C. T. R. Wilson, and Sir A. Schuster.

ROYAL SOCIETY OF MEDICINE (Study of Disease in Children Section), at 5.—Dr. E. Pritchard: Rickets (Presidential Address).

PHYSICAL SOCIETY OF LONDON, at 5.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Adjourned Discussion on paper by Prof. A. Rateau: The Use of the Turbo-Compressor for attaining the greatest Speeds in Aviation.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—Question and General Discussion Evening.

ROYAL SOCIETY OF MEDICINE (Epidemiology and State Medicine Section), at 8.—Dr. R. J. Ewart: Economics and Tuberculosis.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 8.—Dr. G. H. Rodman: Familiar Flowers in Monochrome.

ROYAL SOCIETY OF MEDICINE (Electro-Therapeutics Section), at 8.30.—Dr. R. Knox: Cardiac Diagnosis: A Survey of the Development of Physical Methods (Presidential Address).

PUBLIC LECTURES.

SATURDAY, OCTOBER 21.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Miss M. A. Murray: The Nile in the Life and Religion of the Ancient Egyptians.

MONDAY, OCTOBER 23.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. Shattock: Specimens illustrating Carcinoma.

CITY OF LONDON Y.M.C.A. (186 Aldersgate Street), at 6.—Sir Walter Morley Fletcher: Man's Body and the Making of Athletic Records.

TUESDAY, OCTOBER 24.

SCHOOL OF ORIENTAL STUDIES, at 5.—Prof. Alice Werner: Some Bantu Tribes of the Tanganyika Territory. Succeeding Lectures on November 7, 21, December 5, 19.

GRESHAM COLLEGE, at 6.—Sir Robert Armstrong-Jones: Physic. Succeeding Lectures on October 25, 26, 27.

WEDNESDAY, OCTOBER 25.

KING'S COLLEGE, at 4.30.—Dr. C. Da Fano: The Histology of the Nervous System. Succeeding Lectures on November 1, 8, 15, 22, 29, December 6 and 13.

SCHOOL OF ORIENTAL STUDIES, at 5.—Mrs. Rhys Davids: How to find the Real Founder of Buddhism. II.

UNIVERSITY COLLEGE, at 5.30.—A. Lloyd-Jones: The Phonetic Structure of the Yoruba Language.—L. S. Jast: The Organisation of a Great Library.

THURSDAY, OCTOBER 26.

CITY Y.M.C.A. (186 Aldersgate Street), at 6.—Sir C. Hercules Read: The Ancient Briton as Artist and Craftsman.

FRIDAY, OCTOBER 27.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Results following Resection of the Bowel, illustrated by Experimental Work done by Mr. T. Gray on Cats.

UNIVERSITY COLLEGE (in Botany Department), at 5.—Prof. A. H. R. Buller: Studies in the Morphology and Physiology of Fungi. Succeeding Lecture on November 3.—At 5.15.—Prof. J. Adams: The New Individualism in Education.

BEDFORD COLLEGE FOR WOMEN, at 5.30.—J. M. M'Gregor: Social Life in Athens, as illustrated by Plato.

SATURDAY, OCTOBER 28.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—F. Balfour-Browne: The Life and Habits of Mason Wasps.